3 1761 06704361 2

acq'd Aug. 1/16
by the Auditor

Digitized by the Internet Archive
in 2007 with funding from
Microsoft Corporation

http://www.archive.org/details/systemofophthalm02wooduoft

MEye
W

A SYSTEM OF

OPHTHALMIC OPERATIONS

Being a Complete Treatise on the Operative Conduct of Ocular Diseases and Some Extraocular Conditions Causing Eye Symptoms.

Edited and Partly Written by

CASEY A. WOOD, M. D., C. M., D. C. L.

Late Professor of Ophthalmology and Head of the Department, Northwestern University Medical School; Ex-President of the American Academy of Medicine, of the American Academy of Ophthalmology and of the Chicago Ophthalmological Society; Ex-Chairman of the Ophthalmic Section of the American Medical Association; Mitglied der Ophthalmologischen Gesellschaft, etc.; Editor of a "System of Ophthalmic Therapeutics," etc.

Completely Indexed and Illustrated with Eighteen Color Plates and over One Thousand Drawings in Black and White, Many of them Original

---

Complete in Two Volumes

VOLUME II

139391
27/8/16

Chicago:
CLEVELAND PRESS
1911

Copyright 1911
by the
CLEVELAND PRESS
Chicago

CHAPTER III.

THE SURGICAL TREATMENT OF CORNEAL ULCER AND FISTULA.

By H. B. CHANDLER, M. D., Boston, Mass.

Historical Review—Corneal Grafting or Keratoplasty—Surgical Anatomy of the Cornea—Operations for Corneal Ulcer—Other Surgical Treatment—Paracentesis—Technique — Complications — Curetting — Technique and Complications—Chemical Cautery to Corneal Ulcer—Technique—Applications of Oxygen, Hydrogen Peroxide, Salicylic Acid Compound, Zinc Sulphate, Tincture of Iodine, Chromic Acid, Sublimate, Carbolic Acid, Iodized Phenol, Acetic Acid, Lactic Acid, Monochloracetic Acid, and Other Corneal Cauterants — Thermocautery — Martinache's Method—Paquelin Cautery—Galvano-cautery—Method of Application—Complications in the Use of the Thermocautery—Corneal Fistula and Various Operations for Its Relief—Capillary Drainage in Hypopyon Ulcer—Hot Air Cautery—Stains for Corneal Ulcer—Escorcin, Methylene Blue, Pyoktanin, Fluorescein, Uranin.

History of Corneal Operations.

The translation of the papyrus Ebers, 16th century B. C., reveals the fact that the priesthood controlled the treatment of all diseases, religious rites and ceremonies playing the most important part in administering even simple remedies.

Whatever little knowledge we have of the history of diseases and their treatment up to the time of Hippocrates, is supplied by non-medical writers, and is therefore unsatisfactory.

Hippocrates prepared a system of rational medicine. In diligently searching his translated works I find no mention of any surgical interference with the cornea. He was a believer in the efficacy of the actual cautery, and advised incisions to the margin of ulcers in general, but there is no evidence that he used it in corneal ulcers.

After the death of Hippocrates there seems to have been a number of ignorant travelling oculists, who, we are told, failing to relieve ulceration by ordinary medication, resorted to cupping, curetting and the application of actual cautery.

Galen, a man of tremendous energy, dogmatic and fearless, stigmatized these travelling oculists as "moneysuckers," and demanded that they should be prohibited from practising.

Galen does not seem to have taken any particular interest in treatment of the eye. We find him recommending to his patients one of his contemporaries, an oculist named Justus, whose treatment of corneal abscess consisted of shaking the patient's head in hopes of rupturing the abscess. He,

however, used the actual cautery, for we find him cauterizing the surface of the cornea with a red hot stylet; and rubbing into the surface nut-galls mixed with iron, for the cosmetic effect in leucoma. He also excised corneal staphyloma.

So strong was Galen's belief that loss of aqueous meant blindness, that his influence deterred oculists from surgical interference with the cornea well into the eighteenth century.

The Arabian School of Medicine was the offspring of the Greek School, and it selected from the writings of Hippocrates and Galen not only the most rational of their teachings, but, with wisdom, countenanced the popular modes of treatment which had proved efficacious.

It is said they performed an operation for the cure of pannus similar to that known as peritomy, and we find that they cupped, curetted and used the actual cautery.

On the decline of the Saracenic universities, and from the ninth to the twelfth centuries, we find the treatment of diseases of the eye passing into the hands of priests and wandering Jews, while all forms of quackery prevailed; setons, incisions of the brow and scalp, mixed with superstitious performances, took the place of the more rational forms of the preceding centuries, and the use of leeches greatly increased.

The founding of the University of Paris, 1205, and other medical schools of the thirteenth century, did nothing to advance the surgical treatment of corneal disease, as graduates were prohibited from practising any form of surgery.

The Guild of Barber Surgeons, men without education, were the operators on the eye, and this continued until 1745. Banister, in 1621, describing these quacks, says:

> "Yet, they that hardly teeth can draw,
> Unless they spill much blood or break the jaw,
> Will deal with eyes and boast of famous facts,
> They have performed in couching cataracts."

About the beginning of the last century a most remarkable advancement in ophthalmology was made; Beer, Schmidt, Himly, Langenbeck, Graefe and a number of others, by scientific study and patient investigation, gave an impetus to this branch of medicine.

Since this time so numerous have been the operations suggested for surgical relief of diseased corneæ, that it is impossible, in this limited history, to review but a few of the most important.

The treatment of large corneal ulcers previous to 1870 had been unsatisfactory. Saemish recommended keratotomy, which proved of great value, and later, Martinache (1873) and Gayet (1879) introduced the cautery for the treatment of corneal ulcers.

Chemical cauterization, according to Nettleship, was not generally used until 1885; there was, however, one exception, nitrate of silver.

From the earliest times every effort has been made to transplant corneal tissue. Pellier first tried the operation in 1802; the corneal tissues of many animals, including that of fish, have been implanted without success; large and small trephines have been devised, but so far with the exception of one of two isolated cases, it has been a failure.

Surgical Anatomy of the Cornea and Sclera.

The cornea forms about one-fifth of the total area of the external eyeball; although placed directly in front it is protected to a limited extent, by the bony projections of the orbit at margins and by the lids. It is nearly circular, measuring transversely 11.9 mm. and 11 mm. vertically; posteriorly it is circular, measuring 13 mm. in diameter, the

difference in size being due to the overlapping of the sclera, forming what is known as the *limbus corneæ and grooved sulcus scleræ.*

The palpebral fissure exposing the cornea and sclera varies, with an average of about 30 mm. transversely and 13 mm. vertically.

When looking straight forward, the fissure is slightly oblique, the outer canthus standing 4 to 5 mm. higher than the inner.

The width of the fissure varies somewhat; when the eye is rolled outward it increases; when rolled inward it diminishes.

As a rule the upper lid overlaps the cornea from 1 to 2 mm., especially in the aged.

The *thickness of the cornea peripherally* is 1.2 mm.; *centrally* 0.8 mm. In health the cornea is perfectly transparent, a condition which is due probably to the compactness of its tissue. It is composed of five distinct layers, anterior epithelium, anterior limiting membrane (Bowman's), substantia propria or stroma, posterior limiting membrane (Descemet's), posterior endothelium. *Surgically,* we must remember, the corneal tissue proper is made up of lamellæ, some sixty layers. A dull-pointed or ill-directed instrument may slide between these layers and not enter the anterior chamber.

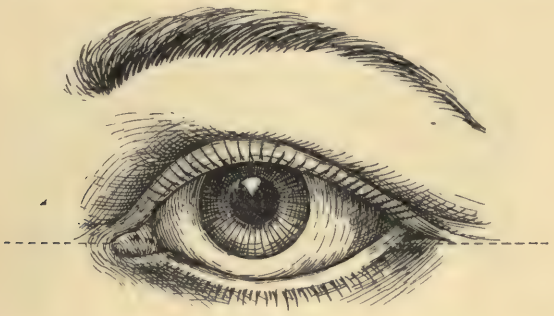


Fig. 447.

Eyelids Naturally Open, Horizontal Plane Passes Through the Inner Canthus.

A healthy, normal cornea contains no blood vessels except peripherally. The nerves of the cornea are numerous and are derived from the long and short ciliary nerves.

The sclera or sclerotic coat forming the posterior four-fifths of the globe, is a firm white fibrous structure, varying in thickness. Posteriorly 1 mm., it gradually becomes thinner, being .4 mm. just before the insertion of the ocular muscles, and re-enforced by the tendinous expansion it thickens to .6 mm. Its structure is fibrous, interlaced with fine elastic fibers. It is sparingly supplied with blood vessels and nerves.

The exposure of scleral tissue is a little less than twice the corneal. Covering the sclera and attached to it by lax and slender bands of

fibers is Tenon's capsule, near the corneal junction it becomes firmly blended with the sclera.

SURGICAL TREATMENT OF CORNEAL ULCER.

The surgical treatment of corneal ulcer is comparatively modern. Galen's belief and teachings, which extend into the 18th, and even 19th century, that loss of aqueous meant blindness, probably deterred oculists from surgical interference. Observation showed, however, that rupture of the cornea in ulceration is usually beneficial rather than detrimental.

Among modern procedures are: *paracentesis* or corneal puncture; *keratotomy* of G. J. Guthrie (the so-called Saemisch section); *curetting; cauterization,* chemical, thermic and electric; *capillary drainage; suction.*

Paracentesis.

When the milder forms of treatment have proved ineffectual, and

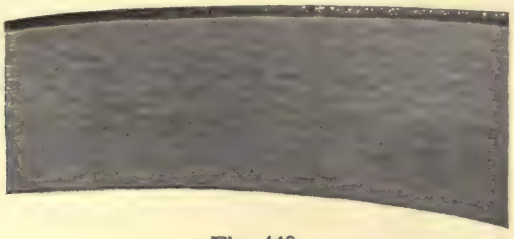


Fig. 448.

Normal Cornea, magnified Thirty-six times. Note the Increased Thickness towards the Limbus (Verhœff).

there is a tendency in the ulcer to spread, or pus in the anterior chamber gradually increases, paracentesis is performed, not only to lower the tension of the eye, and increase the nutrition of the cornea, but also to allow escape of imprisoned pus.

The oldest of modern text-books and earliest ophthalmic literature speak of and recommend this procedure. The operation, with due care, is devoid of danger, and is effectual in that ulceration following contusion of the cornea, so often seen where large numbers of stone cutters[1] are employed; also in the so-called oyster-shucker's corneitis.[2]

In these cases the patient presents himself with a history of having been struck by a piece of stone or shell. There is some circumcorneal injection and slight lachrymation; fluorescin shows no marked loss of

[1]McDowell. *Virginia Medical Monthly,* Oct., 1879.

[2]See Randolph. "A Clinical and Experimental Study of the So-Called Oyster Shucker's Keratitis." *The Johns Hopkins Hosp. Bull.,* Nos. 56-57, Nov.-Dec., 1895.

corneal epithelium, or perhaps one or two very small points. In twenty-four to thirty-six hours the cornea becomes edematous or loses its transparency centrally, the eye becomes more congested, and a corneal abscess develops. A timely paracentesis, repeated, or the wound kept patent for two or three days usually effects a speedy cure.

Operation.—Under local or, in children, with general anesthesia, a well-fitting speculum being inserted (so that there will be no undue pressure on the globe) the conjunctiva is grasped with fixation forceps.

Desmarres' or Galezowski's keratome or paracentesis needle (q. v.) is then inserted into the anterior chamber and slowly withdrawn; in withdrawing the knife or needle it can be rotated, so there will be no sudden gush of aqueous, which may induce prolapse of the iris.

I prefer to withdraw the knife, and then gently press the external edge of the wound; by this means we can better control the flow of aqueous.

A bent, broad needle, Beer's triangular knife or a Graefe cataract knife may be substituted for the needle.

Operators differ in regard to the angle at which the knife should be inserted. Fuchs advises entering it at right angles to the cornea, and as soon as the point has entered the chamber, to depress the handle, so that the blade will be parallel with the plane of the iris.

de Schweinitz recommends passing the knife at an angle of 45 degrees; others enter the chamber with the blade parallel to the plane of the cornea. It makes little difference which way the knife enters so long as the point is sharp and penetrates easily.

Site of puncture.—Where there is a deep ulcer and bulging of the floor, the majority of surgeons prefer to perforate the floor of the ulcer.

Ball[3] believes that when paracentesis is indicated in corneal ulcer, the opening should be made not through the floor of the ulcer, as is usually advised, because of the danger of infecting the eye, but with the exercise of care an opening may usually be made through the normal tissue, and infection should not follow.

In cases where there is thickened pus at the bottom of the corneal chamber, a small puncture through the floor of the ulcer will not remove it; it is better then to make an incision at the posterior portion of the cornea, and, if necessary, withdraw the pus with the point of the iris forceps.

The *size of the operative wound* should depend on the object of the paracentesis. When we desire to reopen the wound daily, it should not be less than 3 mm. Too large a wound may be followed by prolapse.

[3]Ball. *Modern Ophthalmology*, 1904, p. 355.

Complications of paracentesis.—Prolapse of the iris may follow, although I have never seen this occur. Should such a complication happen, an attempt may be made to replace it, and should this be found impossible, it should be drawn out and excised. Infection of the wound may happen, but is very rare, I having seen but one case in several hundred operations.

Curetting.

The treatment of corneal ulcer by curetting probably dates back to the middle ages; the use of knives, spuds or stiff brushes for the removal of dead or sloughing tissue having been commonly resorted to at an early date.

The sharp spoon-curette is modern. It varies in size and shape, as shown in the figures. Great care should be taken before using to see that it is sharp and properly sterilized, as from its shape it is difficult to keep clean.

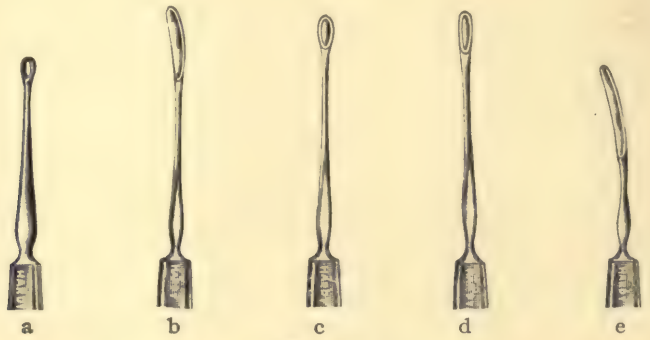


Fig. 449.

Ophthalmic Curettes of Various Shapes and Sizes. a, Wescott's Corneal Curette; b, de Wecker's Curette; c, Helbra's Curette; d, Fenestrated Curette; e, Daviel's Long Curette.

Knapp[4] advocates its use in pustules of the cornea, round or oval, with gray or yellow deposits of inflammatory products; marginal small infiltrations, which, if unchecked, coalesce and form crescentic, annular, progressive ulcers; those irregular, progressive infiltrations of the cornea, which, starting at or near the center, show in different places denser white or yellowish spots, known under the name of dendritic, serpiginous or malarial keratitis; other disseminate, punctate infiltrations, evidently of bacterial origin, for instance, tuberculous or trachomatous.

Operation.—A drop of solution of fluorescin, or some other staining fluid, should be dropped into the conjunctival sac and the lids closed

[4]Knapp. *Norris and Oliver's System of Diseases of the Eye*, Vol. 3, p. 822.

until the smarting, occasioned by its use, has subsided; the excess of the stain should be washed away with sterile water. A local anesthetic is now used two or three times until perfect insensibility is induced.

The lids may be held apart by the fingers of the operator's own hand or by those of an assistant. The stained tissue should now be thoroughly scraped away. In deep ulcers care must be taken not to perforate the floor, remembering that the infiltrated tissue stains a little beyond the diseased portion. When the ulcer is large and considerable diseased tissue is to be removed, a fine stream of sterile water from an irrigator should be thrown on it after the curetting—not at a right angle with the plane of the cornea, but sideways, at an acute angle.

In some cases it will be necessary, if the infiltrate is covered, to remove the covering with the point of a sharp knife.

As soon as the ulcer looks clean from the curetting, its whole surface should be touched with tincture of iodine or some other germicide. A drop of olive oil applied will lessen the irritation. This treatment may have to be repeated if the ulceration still shows activity. Subsequent treatment with atropin and other collyria should be used. When hypopyon is present and tends to increase, corneal puncture will have to be done in addition to the curetting.

Complications of curetting. The only complication likely to occur is in deep ulcers, when we have been too energetic, have perforated the cornea and a prolapse of iris takes place. Should this occur the iris should be immediately drawn out through the rupture and excised.

Chemical Cauterization of Corneal Ulcer.

Applications of strong caustics, germicides or escharotics in corneal ulceration, with the exception of silver nitrate, were not generally used, according to Nettleship,[5] until about 1885; since that time a large and still increasing number of these remedies has been advocated.

In the hands of careless or incompetent practitioners, the use of the stronger caustics is a source of danger and, unless used with great care, their field of action is liable to be enlarged by the flow of tears, so that not only the diseased portion is cauterized, but the surrounding healthy tissues badly damaged.

Preparation.—No speculum or fixation forceps is necessary, the lids being held apart by the fingers. The eye is thoroughly anesthetized locally, and fluorescin used to map out the diseased area.

In a small, superficial ulcer, the caustic can be applied directly to its surface. In *a large, sloughing ulceration,* with considerable dead or disorganized tissue over or surrounding it, it should be *cleansed as much as possible with the curette and by irrigation,* before the applica-

[5]Nettleship. Chronic serpiginous ulcer of the cornea (Mooren's ulcer). *Trans. of the Oph. Soc. of United Kingdom,* 1902, Vol. 22, p. 103.

tion of caustics. If this fails to check or improve the pathological process, resort should be had without delay to the actual cautery.

Application.—Fluid caustics should be applied by means of a wooden tooth-pick, which has been dipped, and allowed to remain a few seconds, in the fluid. A few strands of absorbent cotton may be tightly wound on the point provided all loose fibers are snipped off to prevent their touching the healthy tissue. The caustic should be thoroughly rubbed into the diseased part by a rotary movement. It is better to have too little caustic on your applicator than too much. A good suggestion is to dry the ulcer with blotting paper before applying the caustic.

Complications.—None are likely to follow if judicious care is used in the application. Pain is experienced for a few moments to two hours; occasionally there is puffing of the lids, which a cold compress relieves.

The after-treatment consists of atropin in solution or as an ointment, with other appropriate collyria.

Caustics Used in Ulcer of the Cornea.

The following cauterants have been advised.

Oxygen Gas.—Treacher Collins reports a severe hypopyon ulcer cured with this remedy locally applied.

Peroxide of Hydrogen.—G. Edgar Dean (p. c.) says regarding this application: "Without detracting from the value of the Saemisch section in suitable cases of hypopyon ulcer, I desire to state that in my hands at least fifty per centum of the operations of this kind have been obviated in recent years, and without the use of galvano-cautery, which would of necessity destroy some tissue. My plan is to make a delicate point of absorbent cotton, snipping off with scissors the trailing fibers at the extremity. Cocainize the eye, then dip into full strength peroxide of hydrogen, and apply the tip to the ulcerated point, holding it there a few seconds for the antiseptic to penetrate to the deeper layers of the cornea; this is generally repeated daily."

I have used peroxide of hydrogen extensively, and except in superficial ulceration, have found this mode of treatment unsatisfactory. In an active, progressive ulcer, as a preliminary process to more vigorous treatment, decided benefit has followed its use.

Salicylic Acid Compound.—Ewing[6] believes that what is said of the actual cautery may also be said of the majority of chemical caustics, but they are less easily controlled on such delicate tissue as the corneal. As a substitute for over-active caustics, he suggests the use of the following recipe:

---

[6]Ewing. A Useful Mild Caustic; a Relief, Possibly a Cure, for Some Forms of Cancer. *Am. Journal of Ophthalmology*, Nov., 1909, p. 328.

℞

Resorcin	(gr. xi)	grm.	2.60
Salicylic acid	(gr. xx)	grm.	1.20
Carbolic acid	(gr. i)	grm.	.06
Ol. lavender	(gr. i)	grm.	.06
Ol. lemon	(gr. iv)	grm.	.26
Ol. bergamot	(gr. iv)	grm.	.26
Alcohol 95 per cent.	(℥ iv)	grm.	124.40

For cauterizing purposes this solution should be saturated with salicylic acid, which means the addition of (gr. 120) 8.00 grms. to each ounce. The essential oils, the writer thinks, act as an anesthetic.

Zinc Sulphate.—Éperon[7] found great benefit from a twenty per cent. solution of zinc sulphate. He applies it liberally with cotton on a Bowman's sound, and states he has used it in twenty-five cases of serpiginous ulcers with hypopyon. The ulcerated portion becomes covered with the albuminate of zinc. The pain is moderate and controlled by a solution of cocaine and adrenalin.

Iodine Tincture.—It is one of the most popular of the milder caustics. Snellen claims to have first suggested its use. A drop of olive oil after its use relieves the irritation considerably.

Gold Carbolate.—Galezowski recommends its use in 1 per cent. solution.

Formalin.—This application is employed as a 1 per cent. solution.

Chromic Acid.—By heating the bulbous end of a probe and touching the acid, some of the crystals will adhere. By then rotating the probe in an alcohol flame, a perfect bead of chromic acid will be formed. The use of this acid in corneal ulcers is said to be of considerable value. It must be applied with great care, otherwise healthy tissue will be destroyed. The eye should be irrigated with sterile water or salt solution before the lids are closed.

Silver Nitrate.—The oldest and most extensively used of the caustics, is mentioned in the text-book of St. Yves.

It is used either as a solution (1 per cent. to 40 per cent.), in the form of pencil, or fused with equal parts of sodium nitrate under the name "mitigated stick." The safest plan in using solid silver nitrate is to dip the end of the probe into the molten salt. After using silver caustic the eye should be thoroughly irrigated with normal salt solution. Harmon advocates the addition of 3 per cent. to 15 per cent. of glycerine to strong solutions, claiming that the pain and irritation are greatly lessened.

Mercury Perchloride.—Solutions of this salt are extensively used

[7]Eperon. Un Traitement Efficace des Ulcères de la cornée. *Archives D'Ophtal.*, July, 1907, p. 433.

as a germicide, varying in strength from 1 :4,000 to 1 :10,000. As an active germicide Baroggi[8] suggests a one per cent. solution applied to spreading, traumatic ulcers.

Permanganate of Potash.—A solution of 1 to 30 is used by Rollet.

Carbolic Acid.—One of the most (deservedly) popular caustics. The crystallized acid is liquefied by heat or with a few drops of alcohol. None of the caustics in use have proved more efficacious. It was first recommended as an ophthalmic cauterant by E. Williams.[9]

Iodized Carbolic Acid or Solution of Iodine in Glycerine and Carbolic Acid.—This is one of the preparations of the National Formulary. Casey Wood[10] recommends its application pure to corneal ulcers and regards it as one of the best cauterants and germicides we possess. He believes it to be in that respect even better than pure tincture of iodine or pure phenol used alone.

Acetic Acid.—Savage[11] advises touching the ulcer with one drop of acetic acid to 5 or 7 drops of water, by means of a piece of absorbent cotton wrapped around a tooth-pick. He claims the advantage of this acid over other agents is, while it destroys germs it does not destroy cell life, connective tissue or epithelium.

Lactic Acid.—Dolschenkow recommends this acid diluted with one-half water and applied with a glass rod.

Monochloracetic acid is advocated by Fox and Bulson.

Hydrochloric acid is employed in from 10 to 20 per cent. solution.

Nitric acid is used in 5 to 10 per cent solution. Edward Jackson believes this to be a valuable caustic for small ulcerations, especially those surrounded by limited infiltration or infected by foreign bodies; also in recurring marginal ulcers, Mooren's, or acute creeping and superficial ulcers. He dips a tooth-pick of hard, smooth wood into a drop of the acid, waits until it has been absorbed, then presses the point against each part of the surface to be cauterized. Some pain is experienced, which is controlled by the use of holocain.

Iodine Trichloride.—Casey Wood has used this salt in the simpler forms of corneal ulcer, and believes, if preliminary cleansing and other necessary precautions are taken before applying, it will be found a very efficacious remedy.

THE ACTUAL CAUTERY.

Historians tell us that the actual cautery was used in the Middle Ages for the relief of corneal ulcers. Whether this is so or not, we

[8]Baroggi. *Rivista Italiana di Ottal.*, Aug., 1908.
[9]E. Williams. *Report of the Fourth Internat. Ophthal. Congress*, 1873, p. 102.
[10]Wood. *A System of Ophthal. Therapeutics.*
[11]Savage. *Wood's Ophthalmic Therapeutics*, p. 390.

are indebted to Martinache,[12] for the introduction of the method in modern times. He describes his success in the treatment of a chronic ulceration of the cornea, but no complete account of the instrument used is given.

Gayet[13] also did much to introduce this operation. At first, heated needles, sounds and strabismus hooks were used. The alcohol-heated cautery still has its users. Barkan (p. c.) says, "Weiss made, a few years ago, a corneal ulcer cautery for me, which I found very useful. It is essentially a handle armed on one end with a blunt steel probe to be heated in an alcohol flame, according to the method of Martinache, on the other end the handle is provided with a probe which has a platinum end, also blunt, and which retains the heat much longer than the steel probe. These cautery applications to infected corneal ulcers, I find exceedingly convenient and very useful."

The difficulty with this cautery is that one feels hurried in using it; the point cools rapidly by radiation, also when it comes in con-

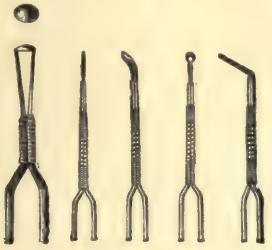


Fig. 450.
Cautery Points.

tact with the fluids of the eye, and when the ulceration is extensive, it has to be repeatedly reheated.

Wadsworth devised a ball cautery with projecting point, which retains the heat longer. Later, Todd[14] modified and improved this model, using a copper ball extending from which is a platinum point placed at an angle of 45 degrees. He states that it retains its heat for several minutes.

The *Paquelin cautery* is an ingenious instrument with internal combustion of benzine in a platinum terminal. It is difficult to keep the point at an even temperature, and for this reason alone I believe it is inferior to the galvano-cautery. Another fault is that in using the instrument the hand is too far from the eye; nor is it as delicate an instrument as the electro-cautery. A variety of terminals has been

[12]Martinache. *Pacific Med. Jour.*, Nov., 1873, p. 94.
[13]Gayet. Cauterization ignée de la cornée. *Gaz. des Hop.*, No. 2, 1877.
[14]Todd. A Simple and Effective Instrument for Cauterizing Corneal Ulcers. *Ophthal. Record*, April, 1908, p. 180.

devised, and the latest models of this instrument are greatly improved. Its advocates claim that the heat generated is more penetrating and beneficial than the other forms of cautery.

Galvano or Electric Cautery.

This is the most satisfactory of all the cauteries. The heat can be regulated to a nicety and the points vary in size and shape. One who has had an opportunity of using the various forms of corneal cautery will, I am sure, not hesitate to choose this one. John A. Donovan[15] states: "A very short electrode in the handle, at an angle with a small platinum wire, is necessary. Nearly all on the market have the point too long; those with flat or spiral tips carry too much heat, or cover too large an area for fine work."

Franke advises a fine platinum loop with a switch under the finger to control the current.

Kuhnt recommends an instrument with the hot part not more than an inch and a half from the fingers.

Fig. 451.
Wadsworth's Cautery.

Indications for the Use of the Cautery.

Czermak[16] advises its employment in the following cases: 1. Corneal ulcers of large extent, progressing in spite of treatment, or very torpid ones. 2. Small, deep marginal ones. 3. In infected erosion or infected deep wounds. 4. In pannus. 5. In rust ring, after removal of iron particles. 6. After removal of pterygium. 7. After removal of malignant growths and papilloma. 8. In staphyloma and conical cornea. 9. Prolapse of iris. 10. Fistula of cornea.

In addition, Franke,[17] believes that in the phlyctenular infiltrates of children the cautery will cure when drugs fail.

Application of the Electro-Cautery.

Fluorescein should be used to map out the ulceration and bring out little foci, which would otherwise be overlooked. Perfect local anesthesia should be induced, speculum and fixing forceps may be used, or the lids separated by the fingers; the sloughing tissue in large ulcers should be removed with curette and irrigation, as there is no reason why we should burn broken down tissue, when we can reach directly the diseased portion below.

---

[15]Donovan. *Trans. Am. Acad. of Ophthal. & Otol.*, April, 1909.
[16]Czermak and Elschnig. *Die Augenärtzlichen Operationen.*
[17]Franke. *Deutsch. Med. Wochenschr.*, 1887.

First, the progressing infiltrated border should be continuously burnt with a fine point, at the same time cauterizing outlying foci. The floor of the ulcer is now gently swept over with the same or a larger (flat) electrode. Great care should be taken not to perforate the ulcer, as prolapse of the iris will follow. Perforate only when the floor is bulging and rupture seems inevitable.

If perforation seems necessary, it is best to make the opening as near the center of the pupil as possible, as by this means we may avoid prolapse.

Should there be a large hypopyon, a paracentesis (q. v.) should be done at the same time, or the day following. Some surgeons advise keratotomy when hypopyon complicates the ulcer.

D. W. Greene suggests heating the cautery to a cherry red, and

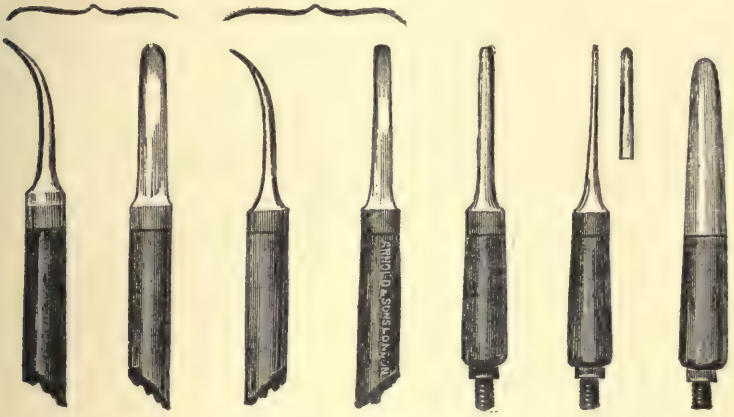


Fig. 452.

Thermo-Cautery (Paquelin) Points.

approaching the corneal surface within one-half mm. of its surface, or as near as possible without touching it, and states that this method produces an effective asepsis, without destroying any normal tissue; and no scarring results. This suggestion should find favor, if efficacious.

The point should be brought to a *red heat;* white heat acts too rapidly, and when there is no glow the cautery is liable to stick to the cornea.

Knapp advises that the burner be held cold on the place to be cauterized, then, by making the connection, bring the burner to red heat and quickly remove it.

The majority of surgeons prefer to bring the terminal to the proper heat before applying, and above all things we must remember the action of the cautery is extremely rapid.

Franke[19] reminds us that scars following cauterization are certainly of lighter color and more transparent than ordinary scars, but in the phlyctenular disease of young people the natural scar thins out, in later years, more than that made by the cautery.

The same observation is true of carbolic acid. However, the density of the cicatrix mostly depends on the depth of the ulcer and the rapidity of the healing process.

Whether one believes in the general use of the cautery or not, there is at least one disease, chronic serpiginous ulcer (Nettleship), *ulcus rodens* (usually known as Mooren's[20] ulcer) which seems to resist all other means of treatment. Nettleship[21] has collected the published histories of over sixty cases. Active cauterization was not, he states, generally used till 1885, and no case of cure reported except by Steinheim, who, by cutting away the overhanging edge and applying carbolic acid, effected a cure.

Fig. 453.

Plain Interrupting Handle for Electrodes.

Randolph[22] has written an admirable article showing how little effect all forms of treatment have in rodent ulcer except the actual cautery.

No timidity should be shown in the treatment of this (fortunately) rare disease. All the erosions and overhanging edges should be snipped off with fine iris scissors, and the edges thoroughly burnt; it is better to sacrifice some of the healthy tissue than to lose the eye. I can speak from experience, having treated three of these cases, the cornea of the first two having been destroyed.

Complications in the Use of the Cautery.

In spite of the application of the cautery, the ulcer may extend and the edges have to be retouched either by the cautery or some active chemical caustic. The majority of cases, if thoroughly cauterized, will show within twenty-four hours a decided change, the edges of the

[19]Franke. *Deutsch. Med. Wochenschr.*, Jan., 1887.
[20]Mooren. *Ophthal. Beobactungen*, 1867, p. 167.
[21]Nettleship. *Trans. of the Oph. Soc., United Kingdom*, 1902, Vol. 22, p. 103.
[22]Randolph. *Journal Am. Med. Assn.*, July 24, 1909, p. 270.

ulcer losing their dead or dull appearance, and becoming more glazed and healthy looking.

Prolapse.—When this unfortunate complication occurs, we must find means of preventing its increase as soon as possible. Where the prolapse is small, puncturing it, using miotics and compressive bandage, may prevent further increase, and eventually form a firm, flat cicatrix.

Trying to replace a prolapse with a blunt probe is, in a majority of cases, practically useless. Many authors advise the use of the actual cautery in small prolapses.

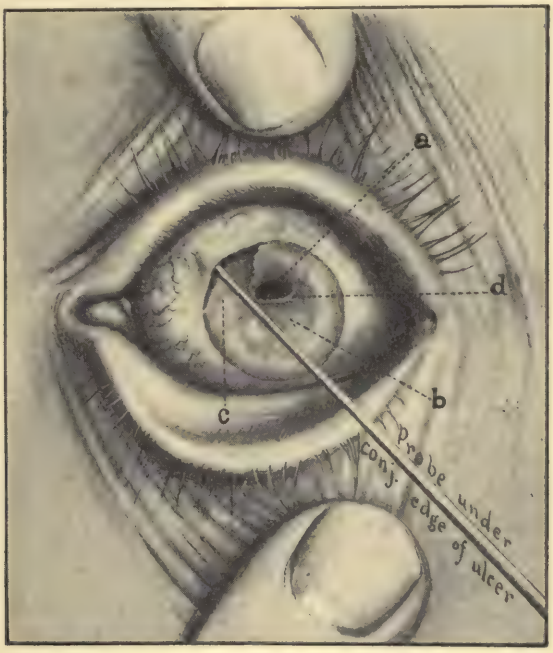


Fig. 454.

Rodent Ulcer of the Cornea. *a*, The only part of the Cornea which has not been attacked but which is gradually becoming hazy with approach of the ulcer. *b*, Area of Cicatrization after ulcer has run its course. *c*, Ulcerative Process is especially marked in this area (note undermined limbus). *d*, Corneal or progressive edge of ulcer, showing crescentic shape which was more marked in early history of case. This edge is also undermined. (Randolph.)

Personally, I believe the only safe treatment of prolapse is its excision. The use of the cautery is rapid and the immediate result is good, but there is one element of danger; I have seen three cases of sympathetic inflammation follow its use.

Fuchs, in his admirable text-book, says that the performance of excision is possible only in *recent* prolapses. After a few days the

iris becomes firmly adhered to the margins of the perforation. In larger prolapses one should try to transform the prolapse into a firm, flat cicatrix.

When there is a mushroom prolapse, puncture and apply the pressure bandage.

Kirschler recommends in large prolapses, with a tendency to corneal staphyloma, splitting the cornea transversely and, after opening the anterior capsule, expelling the lens.

In excision of the iris we should be sure no adhesions are present between the iris and the margin of the perforation; if present, they should be broken, either with a blunt probe or by pulling them off. The iris is then drawn out and cut off close to the cornea. When the opening is of some size the formation of a flat cicatrix may be assisted and the opening filled with a conjunctival flap (q. v.), after the method either of Schöler, Kuhnt or Da Gama Pinto.

CORNEAL FISTULA.

This condition, fortunately rare, occurs as a result of an imperfect healing process. If, during cicatrization, the delicate membrane occluding the opening is repeatedly ruptured, the perforation may, at length, remain permanently open and a fistula of the cornea is formed. The fistula then appears under the guise of a small dark point surrounded by whitish cicatricial tissue.

The anterior chamber is usually empty, or filled from time to time, only to be again emptied. The tubular opening, after existing for some time, becomes lined with epithelium; and this prevents its closure. Should the fistula remain open for any length of time, atrophy of the globe or panophthalmitis may follow.

Operation.—The early writers speak of touching the fistula with silver nitrate. DeWecker has reported a cure brought about by using a fine-tooth forceps and tearing the walls of the tubular opening.

Electrolysis.—Cornwall reports a case cured where the fistula was small and situated near the periphery; he used the point of a jeweler's brooch, bent at right angles, the point being about 1 mm. long. Under cocaine anesthesia this electrode was inserted in the opening, the point rotated to produce erosion and a one-fourth ma. current was used; after which the eye was bandaged for two days.

Iridectomy and fine corneal sutures have been recommended, but this treatment usually proves futile.

Galvano-cautery.—This method is probably the most satisfactory; a very fine, pointed electrode being used, and the epithelial lining destroyed. There is more or less danger to the lens during this procedure.

Ball[23] suggests that a keratome should be introduced beneath the fistula before using the cautery. It is hardly necessary to state that the anterior chamber must be re-established before this can be done.

To me the most plausible method of treatment of fistula is to pack the conjunctival sac with a vaseline ointment of arecolin, and keep the lids closed by means of a light compress. As soon as the anterior chamber has been re-established, the epithelial lining of the tubular opening should be thoroughly destroyed. Aqueous will be lost in doing this, but by repacking we can re-establish the anterior chamber until a firm cicatrix is formed.

Capillary drainage is advised for the treatment of *hypopyon ulcer* by Rollet and Moreau.[24]

They report 17 cases cured by this method, and describe the operation as follows: With a Graefe knife a puncture and counter-puncture are made in the lower part of the limbus. A single horse hair is then, after thorough sterilization, passed through both openings. When difficulty arises in passing the hair, a hypodermic needle is first introduced, the hair passed through the needle and the needle withdrawn. The hair is left projecting 2 or 3 cm. on each side of the cornea for drainage. The eye is then dressed and closed.

Hot Air Cautery in the Treatment of Corneal Ulcer.—Grossman[25] considers the use of the galvano and the thermo-cautery not entirely satisfactory, since these methods completely destroy the tissues, and it is impossible to regulate the temperature accurately. The instrument employed by Grossman was devised by Hollander, of Berlin, and consists of a Paquelin cautery, inside of which a platinum coil is placed. The air in the coil is heated by the Paquelin with benzolin, and the rubber tubing is so arranged that the same set of bulbs which supply the Paquelin with the benzolin mixture, sends an ordinary fresh air current through the heated metal coil. The heated air comes out of the nozzle, and regulation of the temperature depends on its distance from the cornea. The action of the hot air dessicates the central part, which becomes white, and it also has some influence on the surrounding cornea; the latter soon regains its normal transparency unless the cauterization has been carried too far. To confine the burning to a limited area, a mica shield is advised with a perforation of suitable size.

Stains for Corneal Ulcer.

These reagents are employed to stain the diseased portions of

[23]Ball. *Modern Ophthalmology*, p. 358.

[24]Rollet and Moreau. Traitement de l'hypopyon par le drainage capillaire de la chambre antérieure. *Rev. Gen. d'Oph.*, November, 1906, p. 481.

[25]Grossman. *British Medical Journal*, Aug. 26, 1905.

the cornea, and assist in the diagnosis by localizing defects of corneal epithelium, bringing into relief the extent of the infiltration and the depth of the ulcer, while they assist the surgeon to estimate the amount of loss of corneal epithelium and stroma. Thomalla[26] was the first, or one of the first, to advocate the use of stains. He gives the credit for the suggestion to Straub.

Escorcin is derived by decomposition from esculetin. Frolich uses a drop of 20 per cent. alkaline solution, which stains the tissues red. He claims that defects are made more conspicuous than by fluorescin or other stains.

Methylene Blue. (Methylthion, Methylthionine, hydrochloride.) This agent is recommended by Melville Black in a 2 per cent. solution. He claims that it is more effective and easier to use than fluorescin; also that it has a therapeutic value.

Pyoktanin blue (methyl violet) and pyoktanin yellow (apyonine) are aniline dyes, both soluble in water or alcohol, and made by Merck in pencils for staining.

Fluorescin. Resorcinolphthalein anhydride. This reagent occurs as yellowish-brown crystals, obtained by fusing 7 parts of resorcin and 5 parts of phthalic anhydride. It is only slightly soluble in water, but is very soluble in alcohol; with ammonia, sodium and liq. potassæ it forms various colored solutions. Used alone or with alkaline solutions, the corneal ulcerations or abscesses are tinted yellow or green.

Casey Wood[27] prefers the following formula:

℞

Fluorescein.	(gr. viii)	grm. 1.1
Liq. potassæ	(fl ℥ss)	grm. 2.0
Aq. dest.	(fl ℥i)	grm. 30.00

This should be allowed to stand ten days in a cool dark place, and then filtered.

Uranin.—The sodium salt of fluorescein, very soluble in alcohol and water, may be used like the potassium compound, but it is not as satisfactory.

Benson[28] believes that where the cornea stains in whole or in part, the stained part represents: 1. An ulcer not yet covered by epithelium. 2. An abrasion of the epithelium. 3. Epithelium in a dead or diseased condition, though not necessarily in a dying state.

---

[26]Thomalla. *Centralbl. f. prakt. Augenheilk.*, Nov., 1889, p. 322.
[27]Wood. *A System of Ophthalmic Therapeutics*, p. 468.
[28]Benson. The Value of the Fluorescein Test. *Opthal. Review*, May, 1902, p. 121.

The fact that staining is not always an indication *for active treatment* should remind us that, in this connection, the characteristics of the ulcer should also be considered. For example, the contusion area in the cornea resulting from a blow may stain and yet no ulceration result.

As a rule cocain is instilled before using fluorescein; this induces corneal desiccation, and, I believe, somewhat misleads us as to the area of the diseased tissue. The smarting or irritation induced by a drop of fluorescein lasts only a few minutes, and if the eyes are closed, is insignificant.

The surplus stain, in employing the foregoing agents, should be washed away with sterile water or any other irrigating fluid.

CHAPTER IV.

PARACENTESIS, KERATOTOMY, CONJUNCTIVOPLASTY AND SOME OTHER OPERATIONS ON THE CORNEA.

By CHARLES A. OLIVER, A. M., M. D., Philadelphia, Penn.

Abrasion or Scarification of the Cornea—Paracentesis of the Cornea for Ulcer—Peritomy—Peridectomy—Paracentesis of the Cornea for Various Purposes—Haberkamp's Method of Galvano-puncture—Kerotomy—Keratotomy or Guthrie's Operation, the So-called Saemisch Section—Schwenk's Incision—Combined Transverse Keratotomy for Operations on Corneal Staphyloma—Operations for Keratoconus—Treatment by Ligation and Seton—Cauterization of Corneal Staphyloma—Incision of the Staphyloma—Ablation, Abscission and Excision or Staphylectomy—Iridectomy in Staphyloma Corneae—Excision of Prolapse of the Iris—Conjunctivoplasty—Tattooing of the Cornea—Tyson's Method of Tattooing—Barck's Method.

Abrasion or Scarification of the Cornea.

This procedure is an extremely old one. de Saint-Yves[1], in speaking of the cure of "ophthalmies," says that "the general Remedies must be employed, and chiefly BLEEDING to lessen the Quantity of BLOOD." He tells us that it "is to be noticed that the SPOTS, the ULCERS, and certain ABSCESSES of the CORNEA TRANSPARENT, attended with an INFLAMMATION of the CONJUNCTIVA, are more speedily cured by BLEEDING of the EYE, than by any other MEANS." . . . . "This BLEEDING of the EYE is performed in different MANNERS: Some take a Bundle of BEARDS of OAT-BLADES, and make a Kind of BRUSH, with which they scrape the CONJUNCTIVA, and so scarify it; others pass a COVERED LANCET between the Globe and the EYELIDS, and scarify the CORNEA with it. Others slide a CROOKED NEEDLE under the VARIOUS VESSELS which communicate with the SPOT, ULCER, or ABSCESS, and cut the VESSELS which creep on the CONJUNCTIVA. This last OPERATION is

[1]de Saint-Yves. *A New Treatise of the Diseases of the Eyes* (English Translation by Stockton), 1741, pp. 173-174.

the surest and least painful." Von Mead,[2] Gulz[3], and Malgaigne,[4], have also written upon the subject.

Although it has a limited field of usefulness, as all lost tissue is replaced by opaque material, yet it should be more employed than it is. It consists in the removal by excision, scraping, and shaving, of the superficial structures of the cornea, including small portions of the epithelium and the adjacent parenchymatous substance. It is of value in traumatism, and for the removal of superficial opacities, commencing infectious areas, and coarse vascular inflammation, such as pannus, etc. It has been employed for the correction of astigmia.[5]

Demours[6] rightly considers that the primary condition necessary for its proper execution is a delicacy of operative technique and an ability of exactitude in manipulation. He always chooses the most favorable opportunity, both locally and generally for its performance.

Under the title of scarification of the conjunctiva, Liharzik[7] gives a brief description of the method, and states that it is useful in the radical treatment of chronic conjunctivitis, corneal opacities, pannus, pterygium and trachoma.

Szokalski[8] speaks of the procedure.

This method of treatment is combatted by Sichel.[9]

If there is a foreign body, such as a minute particle of dust, etc., imbedded, it should be immediately removed, and all residual material, such as rust, carefully and neatly excised by some form of corneal spud.[10] A soothing wash should be given, a pair of protective dark glasses ordered to be worn, and if there is any doubt as to the result, the patient should not be allowed to work. Watch should be made for the first or slightest sign of infection in the parts. If all goes aright, the patient may be permitted to return to his employment within a day or two's time.

As Wolfe says[11], "When the body has penetrated still deeper into the cornea, so as to look into the anterior chamber, and presents little surface to lay hold of, I follow Desmarres' advice and introduce a lance into the anterior chamber to support the foreign body from behind, and then, enlarging the passage of entrance, push the body forward. V. Graefe's toothed forceps (figure 456) "is the best instrument

---

[2]Graefe and Saemisch. *Handbuch der Gesammten Augenheilkunde*, 1874, III. Bd. I., S. 382.

[3]Gulz. *Oesterreich. medicinische Wochenschrift*, 1842.

[4]Malgaigne. *Annales d'Oculistique*, IX., p. 95, et XIII., p. 211.

[5]Bates. A Suggestion of an Operation to Correct Astigmatism. *Archives of Ophthalmology*, 1894, XXIII., p. 9.

[6]Demours. *Traité des Maladies des Yeux*, 1818, TomeI, p. 281.

[7]Liharzik. *Darstellung sämmtlicher Augenoperationen*, 1844, S. 41.

[8]Szokalski. *Révue médico-chirurgicale de Paris*, 1853, December.

[9]Sichel. *Iconographie Ophtalmologique*, pp. 93 and 94.

[10]A right angled pricker is of service, too.

[11]Wolfe. *On Diseases and Injuries of the Eye*, 1882, pp. 82 and 83.

for the prehension of foreign bodies, and an oculist's case should never be without one, for by means of it we can seize and remove foreign bodies from positions in which, with any other forceps, they would be apt to slip out of sight."

In the writer's hands, the use of the magnet in cases in which pieces of the various types of iron and steel, have become deeply imbedded, has been fraught with the utmost good of result.

Should there be any infection, the case must be placed under surveillance, the general health put to the best, and all associated disease of the eyeball and its adnexa (particularly of the lachrymal apparatus), cared for without producing an undue reaction of the parts.

If an infectious ulcer arises, it should, in accordance with Meyerhöfer[12], be carefully scraped with a curettement spoon and packed with iodoform powder. Atropine to protect the iris, and a cleansing wash of sterile water or a saturated solution of boric acid; the use of dark glasses; stoppage from all work; and daily studies of the case; should be enjoined. In some instances, it is better to make use of a protective bandage.

Paracentesis of the Cornea in Ulcer.

Meyer[13] states that his practice is to forestall impending perfora-

Fig. 455.

Combined Needle and Spud for Removal of Foreign Bodies from Cornea.

tion of corneal ulcer by performing paracentesis at the thinnest part of the membrane, "by doing which, an irregular rent of the tissues with its pernicious consequences, may be prevented."

Theobald[14], in speaking of corneal abscess which, while extending laterally, shows no disposition to reach the surface, wisely advises that it "should be opened by the removal of the overlying corneal tissue with a curet, and should then be treated as one would treat a malignant ulcer—by the application of carbolic acid or the galvano-cautery."

Heymann[15] gives an excellent account of the operation of punction for corneal abscess and ulcer.

Both Fuchs[16] and Martinache[17] have contributed favorably to the subject.

---

[12]Meyerhöfer. *Klinische Monatsblätter für Augenheilkunde*, 1884, S. 151.

[13]Meyer. *A Practical Treatise on Diseases of the Eye* (English Translation by Freeland Fergus), 1887, p. 140.

[14]Theobald. *Prevalent Diseases of the Eye*, 1906, p. 215.

[15]Heymann. *Ophthalmologische Operationslehre, speziell für prakt. Aerzte und Landärzte*, 1903, SS. 51 und 52.

[16]Fuchs. *British Medical Journal*, 1880, II., p. 780.

[17]Martinache. *The Pacific Medical and Surgical Journal*, 1873, November, p. 299.

The operation is also of use for the removal of the many fancifully termed forms of epithelial thickening, chalky depositions, and engorgement of the superficial lymph and vascular channels of the corneal membrane.

The method consists in local analgesia, and the employment of a sharp spoon or scarifier: The affected portion is carefully cleansed[18]. Care should be taken after the procedure, to see that no infection gets near or into the denuded area. The parts are to be thoroughly cleansed and atropine is to be instilled (unless contraindicated by local condition and age). The use of a bandage as an occlusive is not infrequently necessary.

In the treatment of complicated ulcers of the cornea, Veasey[19] employs *curettement* either with an instrument especially contrived for the purpose, or by the so-called hydraulic method.

For the removal of large dense chronic vascular and lymphatic infiltrates, a more extensive procedure becomes necessary. Demours[20] speaks of the value of repeated light scarifications in obstinate cases of chronic keratitis, in which there has not been much reaction.

Fig. 456.
Toothed Forceps of von Graefe.

Kenneth Scott[21] describes the method in the successful treatment of vascularized corneæ.

Not so frequently seen as formerly, are the so-called dense and indelible lead incrustations sometimes following the use of collyria containing acetate of lead. Jacob[22] reports such a case. Mackenzie[23] has repeatedly removed such crusts, which are composed of oxide or carbonate of lead, by means of the sharp end of a probe "leaving the cornea beneath nebulous merely, and susceptible of cleaning completely under the continued application of vinum opii."

Dixon[24] has successfully removed flakes of phosphate and car-

---

[18]The use of fluorescein, in order to outline the exposed area, may be valuable in some cases.

[19]Veasey. The Treatment of Complicated Ulcers of the Cornea. *Therapeutic Gazette*, 15th July, 1897, p. 440.

[20]Demours. *Traité des Maladies des Yeux*, 1818, Tome I., p. 275.

[21]Scott. *The Ophthalmic Review*, 1894, p. 348.

[22]Jacob. *The Dublin Hospital Reports*, V., p. 370.

[23]Mackenzie. *A Practical Treatise on the Diseases of the Eye* (American Edition), 1833, p. 414.

[24]Dixon. *Guide to the Practical Study of Diseases of the Eye* (American reprint), 1860, p. 108.

bonate of lime from an infiltrated cornea with restoration of vision, by carefully removing the overlying epithelium and scraping them free. No other "morbid condition could be detected in either eye; and the patient stated that there had been no inflammatory symptoms during the time the disease had been coming on."

Holmström[25] advises the scraping of superficial and irregularly surfaced maculæ of the cornea. The epithelium is scraped off the opacified area, until a smooth clean surface is obtained. The newly deposited epithelium will be in position in about forty-eight hours' time. The secondary opacity, which, as a rule, is very delicate and smooth, must be treated with hot applications, and massage and ointments, for varying, though uncertain and necessarily long, periods of time, before clearing up.

In cases of central corneal nebulæ, Ferdinands[26] has had improvement in vision follow the gentle rubbing of the opaque cornea with the rounded end of an India-rubber pencil-eraser, for the period of a half-minute or less, the rubbings being repeated every other day.

Hubert[27] states that he has had good results in the treatment of corneal macula and sclerosing keratitis by the use of bipolar electrolysis.

Hall[28] has seen improvement in both new and old corneal opacities follow the use of galvanism. He generally applies the cathode as the therapeutic pole, but if the eye becomes congested, he prefers the direct use of the anode.

In a few instances, it may become necessary to excise some of the affected areas. George B. Johnson, of Franklin, Pa., has reported the cure of a most interesting case of nodular opacity of the cornea by excision. In his communication[29], he states that but twenty-six authentic examples, four only of which have been seen in the United States of America, have been reported to date.

The case was in a sixty-two year old woman. Treatment consisted in the local use of dionin and yellow oxide of mercury for six months without improvement, followed by the excision of the affected area of the left eye, this method of procedure having been decided upon by the fact that it was noticed that clear corneal tissue appeared beneath a nodule which had been removed for histologic examination.

After cocainization, the masses were first excised with a very small scalpel. Following this, the remaining hazy material was shaved off until

---

[25]Holmström Ueber Abschabung von Hornhautflecken. *Klinische Monatsblätter für Augenheilkunde*, January, 1904, p. 43.

[26]Ferdinands. *British Medical Journal*, 16th May, 1892.

[27]Hubert. Des taches de la cornée de leur traitement et en particulier du traitément de la sclérose cornénne par l'electrolyse bipolaire, *Bulletins et mémoires de la société française d'Ophtalmologie*, 1886, p. 118.

[28]Hall. *Canada Medical Record*, August, 1889

[29]Read before the *American Academy of Ophthalmology and Oto-Laryngology;* New York, N. Y., 4th-6th October, 1909.

transparent tissue was encountered. Gentle use of a sharp chalazion curette, completed the procedure.

The right eye was not operated upon, as vision with it was not so seriously impaired at this time, (it has grown somewhat worse since).

After-treatment consisted in the use of iced compresses for the relief of pain, and irrigation with an alkaline and antiseptic solution, two or three times daily. Slight inflammatory reaction appeared, which in about ten days' time, was followed by regeneration of clear corneal tissue that commenced to show at the border of the denuded surface. This improvement slowly continued until in about six weeks after the operation, the entire exposed area became covered with clear and smooth tissue.

Later, the vision of the left eye had increased to two-sevenths of normal, while that of the right eye had lessened to one-third. The author intends to operate upon the right eye should vision continue to fail.

The photographic reproductions show the condition very well.

Peritomy.

This operation, which consists in simply detaching the conjunctiva at the corneo-scleral junction without excision, is also known

Fig. 457.

Nodular Opacity of Cornea, one Year before Operation.

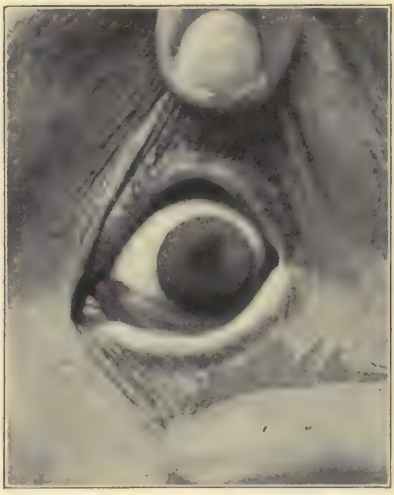


Fig. 458.

Nodular Opacity of Cornea, one Year after Operation. (The white on the cornea is not an opacity, but is due to reflection).

as *circumcision conjunctivæ;* both terms, the latter, a coinage of Critchett, being inadequate and inexpressive of the position of the operation.

It is useful for the lessening of the vascular condition of the epithelial covering of the cornea in so-called trachomatous pannus and some cases of extensive superficial corneal ulceration. It has been employed for the removal of increased superficial corneal vascularization, chronic conjunctivitis, episcleritis, glaucoma, herpes, and kerato-

iritis, by temporarily (or even, permanently), removing the superficial vascularization of the parts which are both directly and indirectly supplied by the vessels of the conjunctiva. Agnew[30] has used it to advantage in persistent pannus. Vacher[31] has made excellent use of what he terms *igneous* peritomy, which consists in a circumcorneal cauterization, in the treatment of corneal sclerosis and episcleritis. Cullere[32] describes a similar proceeding. In the so-called crassus and sarcomatoid varieties of pannus, Panas[33] has resource to the same form of medical treatment. Van Lint[34] makes successful use of what he terms *electrolytic peritomy*. By its employment, the smallest vessels disappear and the cornea regains its transparency. The electrode consists of a platinum sphere of two millimeters' diameter situated upon the end of a curved tip which is connected with a de Wecker instrument. The positive pole is placed on the side of the eye which is to be operated upon. A current of two milliamperes is used. The current is allowed to flow for about ten to fifteen minutes' time. In reality, these procedures should be classed under Peridectomy.

Snell strongly recommends the method in diffuse keratitis, especially in those cases which evidence salmon-colored patches at the corneal periphery. He also employs it in recurrent ulcers, particularly in the old and the middle aged. In his hands (in more than two hundred cases), the healing was more rapid, and the corneæ cleared sooner and better than with any other form of treatment. Beard[35] has employed a modification of the plan, by which he has destroyed the trunk of a few large scattering vessels at the limbus corneæ by means of the galvano-cautery.

Prouff[36] has observed the curative powers of partial peritomy made upon grave ulcers and abscesses situated more or less in the corneal periphery.

For the performance of peritomy, the eyeball and its adnexa are thoroughly cleansed, and their exposed surfaces are analgized by the employment of cocaine. A fold of conjunctiva just beyond the corneoscleral junction is lifted by a pair of fixation forceps, and a small incision is made into it by a pair of sharp, curved scissors. The bulbar or peripheral edge of the incision is then dissected back until a band of

---

[30]Beard. *Ophthalmic Surgery*, 1910, p. 353.

[31]Vacher. Du traitement de la sclérose coréenne et l'épisclérite par la peritomieignée. *Bulletins et mémoires de la Société française d'Ophtalmologie*, 1886, p. 124.

[32]Cullere. De la *Péritomie ignée—Thèse de Paris*, 1886-1887, Num. 195.

[33]Panas. *Traité des Maladies des Yeux*, 1894, I., p. 230.

[34]Van Lint. *Ophthalmology*, April, 1905.

[35]Beard. *Ophthalmic Surgery*, 1910, p. 355.

[36]Prouff. Efficactité curative de la péritomie partielle faite en face des abcès et ulcères graves, plus ou moins peripheriques de la cornée. *Bulletins et mémoires de la Société française d'Ophtalmologie*, 1886, p. 112.

conjunctiva of about two or three millimeters' width is made around the circumference of the cornea, just as far as may be necessary to include the over-vascularized area. Any undisturbed vessels remaining in the exposed area are either divided or obliterated by the actual cautery, or better, by the galvano-cautery. After the procedure, the conjunctival sac must be thoroughly cleansed with a hot solution of boric acid or chloride of sodium. A drop or two of a weak solution of neutral sulphate of atropine is to be instilled, and a monocular fixation bandage is applied.

Reaction, as a rule, is very slight. The case is to be dressed daily. If the conjunctiva at any of the first dressings, shows a tendency to draw itself into its primary position, it is to be loosened and freed by the aid of a flat spatula.

In Agnew's procedure, as Beard tells us[37], the severed portions of the conjunctiva are pushed backward "to a distance of five millimeters by means of a convex-edged scalpel. With the same instrument, the episcleral tissue is also scraped away till the sclera is quite bare, and, where practical, the scrapings are excised. The larger trunks of the corneal vessels are gently scratched longitudinally with the point of the knife, or, what is perhaps better, each of them is touched where it crosses the limbus with a small, red hot, bulbous electrode. No clots of blood nor shreds of fibrin should be left about the field of operation."

Peridectomy.

This operation, also imperfectly termed "syndectomy," is an old one, dating back, in accordance with Hirschberg, to the time of the medieval Arabs. Monteath, in his translation of Weller's *Manual of the Diseases of the Eye*[38], states, while commenting on the value of "scarification, or rather the partial excision of the trunks of the largest vessels running towards the cornea" in the treatment of pannus, that in "place of cutting out portions of the individual vessels, I generally, in obstinate cases of this disease, cut out a portion of the conjunctiva, from a line to a line and a half in breadth, all around the cornea." "This operation," he says, "will not effect a cure, if the patient be at the time in a state of scrofulous dyscrasis or fever; it often rather does harm." Griffiths[39] gives a most interesting method which is practised in Persia. After the insertion of eight small hooks at about a line's distance from the limbus, they are simultaneously lifted and the intervening ring of conjunctival tissue excised with a pair of scissors. Furnari[40] has successfully employed the method under the name of

[37]Beard. *Ophthalmic Surgery*, 1910, p. 353.
[38]1821, Vol. I., p. 215.
[39]Griffiths. *Transactions of the Medical and Physical Society of Calcutta*, Vol. VIII., Part I.
[40]Furnari. *Gazette médicale de Paris*, 1862, Nos. 4, 6, 8, 10, 12, and 14, and *Annales d'Oculistique*, 1863, p. 272.

"tonsure de la conjonctive bulbaire" or *"tonsure conjonctivale"* as an operative measure. It is, he says, when neatly and properly done, a better barrier against disturbing new-vessel formation than peritomy. The procedure is the same as peritomy except, as the term implies, the circumferential band is excised.

Schmidt-Rimpler[41] employs syndectomy in "trachomatous pannus." He excises a circumcorneal band of conjunctiva some two or three millimeters wide, and scarifies the exposed episcleral tissues. The results, he says, are good.

Fox[42] has made a strong plea for the rehabilitation of the operation. He excises a strip of bulbar conjunctiva of two to five millimeters in width, surrounding the cornea. He scarifies "the vessels on the cornea" by means of a Beer's knife. No cauterant is used. The eye is analgized by the instillation of a five per cent strength solution of cocaine, and "excessive hemorrhage may be controlled by the application of adrenalin solution, one to one thousand."

Boeckmann[43] removes a narrow strip of the conjunctiva near the peripheral border in pannus. Verrey[43½] has found (peritomy) peridectomy of value in the treatment of recurrent and tedious phlyctenular affections of the cornea.

Under "peritomy," Herman Knapp[44] says, "I have performed it a number of times. The result was too uncertain, and the danger of sloughing of the cornea was ever present. I think the operation has been generally abandoned." As to any such dangers, Beard[45] has "never seen any untoward consequences from the operation." He tells us, however, that it is generally admitted that these measures "are only to be resorted to when those of a less radical nature have failed to restore to the cornea its transparency."

Paracentesis of the Cornea.

The main indications for this operation are to relieve acute pain and to permit the better action of iridioplegics and cycloplegics in iritis and irido-cyclitis;[46] and to precede iridectomy in some acute cases of glaucoma, in which general anesthesia is contraindicated and in which there is a question of the performance of an iridectomy. It is also of value in some rare instances in which it would not be wise, for some

---

[41]Schmidt-Rimpler. *Augenheilkunde und Ophthalmoskopie*, 1885, S. 455.
[42]Fox. Peritomy or Peridectomy. *Annals of Ophthalmology*, 1903, October, p. 614.
[43]Boeckmann. Trachomatous Pannus and Peridectomy. *The American Journal of Ophthalmology*, April, 1900, p. 97.
[43½]Verrey. *Revue Médicale de la Suisse Romande*, 1891, 20th November.
[44]Norris and Oliver. *"System of Diseases of the Eye,"* Vol. III., p. 353.
[45]Beard. *Ophthalmic Surgery*, 1910, p. 354.
[46]Abadie. *Gazette des hôpitaux*, 1874, p. 219.

reason or other, to immediately attempt to remove some gross form of mechanical pressure upon the intraocular lymph circulation, as in dislocation of the crystalline lens; and in threatened perforation of a corneal ulcer. By some, it has been used tentatively (and, of course, most judiciously), as an adjunct to massage in cases of intraocular embolism and thrombosis. It forms a part of the surgical treatment of keratoconus. Very rarely, indeed, it has been used to advantage for the removal of blood clots situated within the anterior chamber.

For a long period of time the operation has existed "in the domain of ocular surgery."[47] It has been practised for a long time in China and Japan. In 1698, Nuck recommended it formally.[48] He penetrated the central portion of the cornea with a fine trocar, which he plunged into the anterior chamber.

Sperino[49] states that "sur un nombre immense d'opérations faites à la clinique de Turin et dans ma pratique privée, je n'ai jamais observé la suppuration de la plaie."

His views, with the opinions of others for and against its use, are all ably and succinctly given in the same book.[50]

Rivaud-Landrau[51] endorses Sperino's views and methods.

In the first volume of Monteath's translation of Weller's Manual[52], we find the interesting editorial avowal that "The English now employ the evacuation of the aqueous humor, by means of a needle, very commonly, in inflammation of the eye."

In confirmation of this, it will be found that as late as 1840, Mackenzie[53], Middlemore[54], and Tyrrell[55] made use of the method.

Wardrop has written extensively upon its usefulness. He performed it with either a narrow cataract knife introduced into the anterior chamber near the corneal margin with its flat surface held parallel to the plane of the iris. He states that when the desired depth has been reached, the instrument is slightly turned upon its axis to facilitate the escape of the fluid. It should not be allowed to touch the

---

[47]Sperino. *Études cliniques sur l'évacuation répété de l'humeur aqueuse dans les Maladies de l'Oeil.* (French Translation by Charles Reymond), 1862, p. 1.

[48]Ibidem.

[49]Loco citato, p. 16.

[50]Loco citato, pp. 234-245.

[51]Rivaud-Landrau. Compte-Rendue. *Congrès periodique d'Ophtalmologie*, 1862, p. 155.

[52]*A Manual of the Diseases of the Human Eye*, (English Translation), 1821, page 225; from Weller's *Die Krankheiten des Menschlichen Auges*, 1819.

[53]Mackenzie. *A Practical Treatise on Diseases of the Eye*, American Edition, 1833, p. 410.

[54]Middlemore. *A Treatise on the Diseases of the Eye and its Appendages*, 1835, Vol. I., pp. 462-463.

[55]Tyrrell. *A Practical Work on the Diseases of the Eye*, 1840, Vol. I., p. 236.

iris. He made use of the procedure as an auxiliary treatment in all cases of hypopyon.[56]

Lawrence[57] has practised it without any injury to the intraocular structures.

Macgregor[58] states that "It is to be regretted that this operation is not more frequently performed; for I am convinced that many persons have lost their sight from rupture of the cornea taking place in front of the pupil, which a timely and judicious performance of this operation might have prevented." Both Mueller[59] and Langenbach[60] think well of it; while Vetch[61] says that the "testimony which I have to offer on this subject, goes more to establish the safety than the expediency of the operation." Benedict[62] and Rösas[63] have used it in iritis; the latter injuriously so. Carel[64] and Diaz-Albertini[65] speak of its employment in the treatment of hypopyon and perforating ulcers of the cornea.

The procedure is made as follows: General anesthesia is necessary only with children, and in non-contraindicated adult patients who are greatly depressed and suffering from intensely inflamed and hypersensitive eyes. After thorough cleansing of the parts, the eyelids are gently separated. This is best done by the fingers of a competent assistant. The incision, which is generally made with a narrow, bent keratome, or in some cases in which the anterior chamber is shallow, with a narrow lance knife, must be situated to the very best advantage in each individual case. Interference with the iris and the lens capsule should be avoided during the procedure. When the blade of the cutting instrument has been gotten to its proper position, it is tilted slightly to one side, so as to slowly evacuate the anterior chamber of its liquid and solid contents. The knife is then quietly withdrawn, care being taken to keep the patient still during this part of the procedure, which, as a rule, is found by some to be quite painful. The same deliberation and quietude of action is required if the lance knife is used. In order to remove any remaining material which should be taken out, a pair of fine cystec-

[56]Wardrop. *Medico-Chirurgical Transactions*, Vol. IV., p. 142. Also see an interesting paper bearing upon the rationale of the subject in "*The Edinburgh Medical and Surgical Journal*" (2d series), Vol. III., p. 56.

[57]Lawrence. *A Treatise on the Diseases of the Eye*, (American Edition by Isaac Hays), 1847, p. 378.

[58]Lawrence. *A Treatise on the Diseases of the Eye*, (American Edition by Hays), 1847, p. 378.

[59]Loco citato.

[60]Loco citato.

[61]Vetch. *A Practical Treatise on the Diseases of the Eye*, 1820, p. 42.

[62]Ibidem.

[63]Ibidem.

[64]Carel. De la paracentèse de la chambre antérieure dans le traitement de l'hypopion, Thèse de Paris, 1872.

[65]Diaz-Albertini. De la paracentèse de l'oeil dans les cas d'ulcères perforantes de la cornée. Thèse de Paris, 1856.

tomy forceps or a flat spatula carefully introduced, may be necessary. As a rule, flushing of the chambers with a warm normal solution of salt through a bulb syringe, will accomplish the same purpose. Should the iris become prolapsed, which is not very probable if the procedure be judiciously done, it can be replaced, or, in most cases, better, excised.

In case of sloughing ulcer of the cornea, after analgization of the conjunctival sac with cocaine, the eyelids are separated by a stop speculum (although its use is by no means necessary in many instances). This done, a Beer knife, or preferably, a knife needle, is passed through the cornea at the peripheral margin of the ulcerous area. The moment that the anterior chamber has been well entered, the breadth of the blade is carried across the incision, thus making an opening through which the contents of the anterior and the posterior chambers are allowed to make exit. Just as before, care must be taken not to injure the iris or the lens capsule. Atropine should be instilled, the operation field cleansed, and the eyeball covered by a protective bandage. Hot stupes can be applied directly over the bandage. Incarceration of the iris in the corneal wound must be guarded against: For this purpose, in measure, the writer makes use of atropine. According to some surgeons, it may be well in some cases to employ eserine so as to keep the iris tissue tense in order to prevent its prolapse into the wound. If the wound, however, be made oblique, there is but little danger of such incarceration.

The accompanying sketch gives a fair illustration of the method as pursued and depicted by Stellwag.

Abadie[66] also gives an accurate and graphic account of the method in every detail, which is worth careful perusal.

In the performance of paracentesis for corneal ulcer, Schell[67] gives preference to the introduction of the needle through the corneo-scleral ring in such a way that the iris and the lens cannot be wounded.

Todd[68] has devised a modification of Wordsworth's cautery instrument. It consists of a handle and shank with a copper ball at the end of the latter, which has a platinum point extending from it at an angle. The copper ball holds the heat so that the point is sufficiently heated to cauterize the cornea for a period of several minutes' time.

Veasey[69] tells us that among "the more severe remedies at our disposal," should we be unable to check the progress of the ulcer, is the

---

[66]Abadie. Leçons de Clinique Ophthalmologique, 1881, p. 126, et Traité des Maladies des Yeux, 1884, I. p. 244.

[67]Schell. *A Manual of Ophthalmic Practice*, 1881, p. 60.

[68]Todd. A Simple and Effective Instrument for Cauterizing Corneal Ulcers. *The Ophthalmic Record*, April, 1908, p. 180.

[69]Veasey. *Therapeutic Gazette*, 15th July, 1897.

actual cautery, "and in a few cases does the proper use of it fail to prevent the further extension of the disease."

Treatment by means of the thermocautery has been carefully considered by Teleneff.[70]

In cases of slowly-healing injuries to the cornea, in which the endothelial layer of the membrane is pressed outward in the form of a minute hernia, Colburn[71] practises paracentesis of the cornea to lower tension of the eyeball. "The aqueous should be drawn out through the pericornea, thus allowing the hernia to recede and the ulcer to close up." He believes that the use of the galvano-cautery may be required to stimulate the process of repair. He enters the anterior chamber to the scleral side of the corneal junction. The instrument, which may be either a paracentesis needle, a bistoury, or a Graefe knife, must be directed in the plane of the iris. When the chamber is entered, the

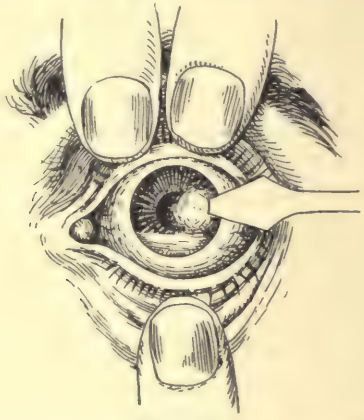


Fig. 459.
Paracentesis of the Cornea, (Stellwag).

instrument must be rotated just enough to allow the aqueous humor to slowly escape, and should be withdrawn before it is touched by the iris.

Bert Ellis[72] makes repeated use of the method in cases of impending perforation of the membrane.

Fuchs[73] considers paracentesis of the cornea a valuable early aid in the prevention of threatened ulcerous rupture of the cornea. He performs it[74] with either a lance knife or a von Graefe cataract knife. The puncture is made about two to three millimeters in length, the lips of

[70]Teleneff. *Vestnik oftalmologii*, XXXIV., 1907, p. 271.
[71]Colburn. *Clinical Lectures on Diseases of the Eye*, 1902, p. 208.
[72]Ellis. Presessional Volume, Section on Ophthalmology of the American Medical Association, 1907, p. 294.
[73]Fuchs. *Lehrbuch der Augenheilkunde*, 1903, s. 181.
[74]Ibidem, S. 841.

the wound being carefully set into proper relationship by the aid of a Daviel's spoon.

Haberkamp's Method of Galvano-Puncture.

This author[75] has devised an extremely radical procedure for the relief of the agonizing pain of fulminating glaucoma in which enucleation is deemed essential. This operation in the hands of one who is unskilled in the use of the cautery, would be, in Beard's opinion[76], (in which the writer thoroughly concurs), "a delicate undertaking, as overheating of the aqueous, with consequent injury to the iris and the crystalline could easily be brought about."[77]

The method consists in a paracentesis of the anterior chamber by galvano-puncture. As the healing of the wound is slow, a prolongation of the effect from that which would be obtained from an ordinary paracentesis, can be gotten.

Dieffenbach[78] cites the cure (!) of a case of a little girl in which he excised a central opacity of the cornea and reunited the parts by a suture. "La cicatrice qui en est résultée est transparente, et la cornée a sa forme normale."

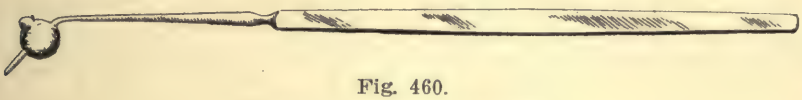


Fig. 460.
Todd's Cautery Instrument.

Kerotomy.

This operation was devised by George Edward Walker in 1886.[79] The reason which led Walker to perform this procedure was the following: He had been impressed by the value and also by the disadvantages of the operation of cutting across a severe ulcer from clear cornea to clear cornea, which Guthrie had advocated in his lectures[80], and "which was revised by Saemisch, and which now unfairly bears his name."[81]

---

[75]Haberkamp. Opération très simple pour le glaucome. *La Clinique Ophtalmologique*, 10th July, 1905, p. 195.

[76]Beard. *Ophthalmic Surgery*, 1910, p. 386.

[77]*Vide* a similar experience by Knapp, in which he considered a resultant cataract (which he successfully extracted) as due to an overheating of the aqueous humor during cauterization of the cornea. Quoted in his article on "Galvano-Causis in Keratoconus" on page 824, in the third volume of Norris and Oliver's "System of Diseases of the Eye."

[78]Ammon. *Zeitschrift*, I. S. 177.

[79]George Edward Walker. On the Treatment of Some of the Graver Inflammations of the Cornea. *Liverpool Medico Chirurgical Journal*, 1889.

[80]George James Guthrie. *Medical Times*, 28th October, 1843, and February and March, 1844.

[81]A. Nimmo Walker. Kerotomy. *The Ophthalmoscope*, November, 1909, p. 740.

The history of the causes which led to the method of procedure is interestingly described as follows:

"In 1886, a case of severe chronic inflammation of the cornea which had resisted treatment for months was brought to Mr. Walker, who found that the whole cornea was involved. Under these circumstances, he argued, 'If a diametrical incision would relieve even worse corneal tension than that which I had before me, why should not a series of shorter incisions whose total length should be the equal or nearly to the length of the diametrical incision do the same? And if so, why should not these shorter incisions be made at the base of the cornea, where they would cause neither damage to the sight or disfigurement?' "

Based upon this thought, he states that "in less time than it has taken to record this, I conceived and performed the operation, the amount of blood and germs which escaped from the incision showing what a relief had been afforded to the cornea, which cleared up perceptibly whilst the operation was proceeding."[82] He goes on to say that "all doubt as to the benefit of the method was soon removed. After recovery from the chloroform the girl expressed herself as quite relieved from the old pain and, two days afterwards, spontaneously opened her eyes for the first time in three months."

As A. Nimmo Walker says[83], the operation is simple. It is best described in his father's original words. "Standing behind the recumbent patient, insert the speculum and fix with toothed forceps the conjunctiva opposite the lowest point of the cornea. Then thrust a broad needle through the sclera, just behind its junction with the cornea, until the shoulder of the needle is visible in the anterior chamber. Of course, the blade must be held nearly parallel with the plane of the iris, but the puncture should be oblique and valvular, so that on the withdrawal no aqueous escapes.

"This puncture should be repeated until the circumference is traversed. In severe cases the bridge between the incisions should be of the same width as the incisions themselves: in cases of less gravity twice or thrice the width. I am in the habit of making about two-thirds of the incision with the right hand and the remainder with the left."

He says that "if carefully performed the operation causes no loss of aqueous or if it does, the fluid is replenished rapidly, so that the anterior chamber is as full after the operation as before. It is important (he tells us), to operate so as to evade this, in order to prevent the additional pain consequent on an empty chamber, and what is more important still, to enable one to complete the incision without endangering the lens."

To this description, A. Nimmo Walker adds the following details: "The operation is more easily performed if the iris is contracted, as the relation of the point of the needle to the lens can be more clearly seen; but, provided that the point is entered well behind the corneo-scleral junction, and kept well up in the anterior chamber, there is no danger of wounding the lens even when the pupil is dilated. The keeping up of the point of the needle is also a safeguard against any sudden movement by the patient, and if this precaution be observed, the operation is free from danger. Indeed, I have never heard of an accident from its use. The number of incisions averages about ten, but varies with the width of the broad needle and with the severity of the inflammation. It is advisable to make the lower incisions first, in order that the bleeding, which should be free, may not obscure the field of operation.

"Except in children, local anesthesia only is necessary, but it must be remembered that, owing to the congestion, longer preparation is required than for cataract or other operations on the uninflamed eye. Usually, the pain is not severe, but if the aqueous be allowed to escape, the sudden alteration in tension causes a twinge. The patients often say that, after the immediate smarting has passed away, they have been relieved of the previous dull aching."

---

[82]The author remarks that this clearing up is a very striking feature in the operation, and has often been remarked by those who have done it.

[83]A. Nimmo Walker. Kerotomy. *The Ophthalmoscope*, November, 1909, p. 740.

He believes "that kerotomy is based on sound pathological principles, and that its curative action lies in the free drainage of the cornea and the relief thereby afforded to the condition of stasis in the lymphatic channels, or, to express it in language of present-day theory, in the removal of toxic substances and the substitution of fresh immunizing fluids. This explanation, (he states), is similar to that given by Axenfeld of the action of paracentesis, but the action of kerotomy is much more powerful as it directly relieves the cornea itself, while it is free from the dangers of paracentesis, i. e., of causing cataract, anterior synechia, and prolapse.

The obvious criticism of the operation, (he tells us), is that it is bad surgery to make incisions into the interior of the eye when the exterior is in a condition of inflammation. This criticism, (he says), applies equally to the paracentesis and Guthrie's operation, and in the present indefinite knowledge of causes of corneal inflammation, and of the virulence or non-virulence of the various organisms found in the conjunctival sac, it is difficult to answer theoretically; but, (he goes on to say), in eight years' personal experience of the operation, during which time I have seen it performed or performed it myself at least 1,000 times, I have never known a case in which the operation has caused septic infection of the interior of the eye."

As A. Nimmo Walker tells us, "It has stood the test of time, and now, twenty years after its inception, it remains the operation of choice, indeed almost the only operation employed in these cases at St. Paul's Hospital."

Keratotomy.

Saemisch's Operation.[84] *(Guthrie's Operation.)*

As now done, the conjunctival sac is cleansed as well as possible. The eyelids are separated with a stop speculum and the eyeball is steadied with a pair of fixation forceps. A puncture of the cornea in the clear portion of the membrane, about a millimeter's distance from the margin of the ulcer, is made with a narrow von Graefe knife with its cutting edge directed forwards. After the knife has entered the anterior chamber, the blade is moved along the bottom of the ulcer until it reaches a similar point in the clear cornea to the nasal side of the ulcerous area. The ulcer is then bisected, the instrument being given a series of slight lateral movements in order to allow the aqueous humor and the removable solid contents to escape along side of the blade. A fine forceps or a flattened spatula, to remove any remaining debris, may be useful[85]. The parts are flushed with sterile water or a saturated solution of boric acid. Atropine is instilled. A compress bandage is carefully applied. It is best in old subjects to give some form of anodyne after the procedure, which does not necessitate general anesthesia; though there will be but little or no pain if the operation be done deliberately, properly and quietly. The after-treatment must be supportive and ameliorative.

---

[84]Saemisch. Das Ulcus Corneæ Serpens und seine Therapie, 1869-1870. (See also an excellent and convincing parallel review of the question of priority—"Guthrie v. Saemisch," by Stephenson," in the April, 1910, number of *"The Ophthalmoscope."* Of particular interest in this regard, is Guthrie's communication published in the 19th of March, 1844, number of the *"Medical Times."*

[85]The writer has not infrequently brought out the entire fibrinous mass by gentle manipulations with the two instruments.

The operation of Saemisch, which he himself modified later, carried the corneal incision through the ulcerous area. An excellent and well illustrated description of the Saemisch section is given by Heymann.[86] Alfred Graefe[87] recommended that the carriage of the section be made in the apparently healthy cornea near the diseased portion of the membrane.

Meyerhöfer[88] "made the cut as a tangent to the ulcer and then slit the infiltrated border, and that in the direction of its greatest progress." As Beard observes[89] "since part of the object of the incision was to drain and relax the infiltrated tissue, as in orbital phlegmon, this would seem rational."

Many cases suffer reinfection, but by judicious repetition associated with careful cauterization whenever necessary, and constant application of hot stupes in connection with rest in bed, and attention to the emunctories, the use of stimulating diet and treament directed towards any dyscrasia, comparatively quick recoveries with useful eyes may, as a rule, be gotten.

Heuermann[90] wrote of the method as early as 1765.

The original method of Saemisch, (Wells tells us)[91] was to carefully and repeatedly open the wound of operation by the insertion of a blunt pointed instrument between its lips once or twice daily, in order to allow any reaccumulated material to escape; the wound being permitted to close at the end of the second or third week. In the writer's experience this repetitive interference with the wound has not been necessary.

Schwenk's Modification of the Guthrie-Saemisch Section.

Schwenk[92] has carefully modified "Saemisch's method of incision" in the following way. He resorts to it only under general anesthesia, as he has found that the release of intraocular tension gives rise to pain. After the parts have been cleansed and a speculum placed in position, he introduces a narrow von Graefe knife—the width of which must be less than the depth of the anterior chamber—one or two millimeters posteriorly to the outer margin of the ulcer—and transfixes it directly to the opposite side of the cornea, keeping the hilt of the instru-

---

[86]Heymann. *Ophthalmologische Operationslehre, speziell für Prakt. Aertze und Landärtze*, 1903, S. 52.

[87]Alfred Graefe. *Klinische Monatsblätter für Augenheilkunde*, 1872, S. 173.

[88]Beard. *Ophthalmic Surgery*, 1910, p. 384.

[89]Ibidem.

[90]George Heuermann. Seine deutsche Beschreibung der Star-ausziehung (1756) und der Operation von Saemisch (1765). *Vide Centralblatt für praktische Augenheilkunde*, Sept., 1890, p. 261.

[91]Wells. *A Treatise on the Diseases of the Eye* (Fourth American Edition), 1883, p. 233.

[92]Personal Communication to the Editor, 1909.

ment as near to the plane of the iris as possible. After having made a counter-puncture, he rotates the knife gently on its axis, but, while doing so, he makes gentle backward pressure with its hilt, the pressure being kept equal to the amount of the bulbar tension in order to hold the iris as much as possible in position, and thus he be enabled to evacuate the contents of the anterior chamber before the completion of the cut. He thus gradually releases all of the tension. This done, he completes the incision by a movement carried directly forward, cutting the ulcer through its center. The fibrinous masses are then removed, and the anterior chamber is cleansed as much as possible.

The author tells us that this operation has proved of much value in his hands. He makes the important note that he has had many cases in which the post-operative result has been uncomplicated by anterior synechia.

Wolfe's[93] method is to introduce a narrow lance knife at the lower border of the corneo-scleral junction, as shown in the accompanying figure. Gentle pressure on the inferior lip of the wound is made during

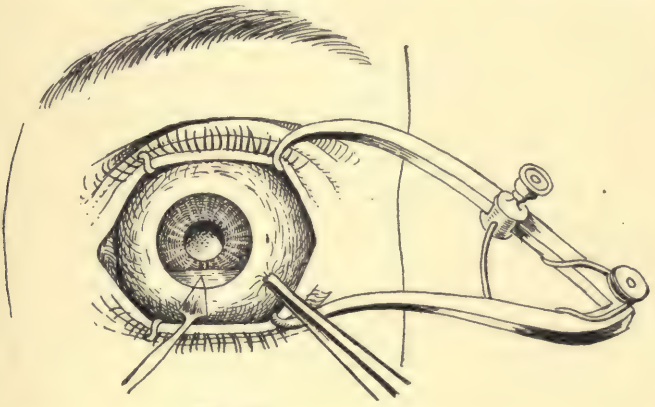


Fig. 461.
Wolfe's Method of Removal of Hypopyon.

the withdrawal of the instrument, allowing the accumulated material to pass out. Any remaining portions are removed by the aid of a small iris forceps and a flat silver probe bent at a suitable angle.

In some cases, in which the cornea is not greatly infiltrated nor necrosed, the writer has obtained most excellent results by resorting to Wardrop's and Wolfe's method of making a peripheral section just within the corneal limbus on the same side as the best portion of the ulcer (preferably the upper). He picks out the free portions of the organized leucocytic (as a rule) masses in the anterior chamber and

[93] Wolfe. *On Diseases and Injuries of the Eye*, 1882, p. 77.

corneal lamellæ[94] with a pair of fine capsule forceps. The after-treatment is as above given. Healing without iris incarceration is uninterrupted, and excellent visual results are nearly always obtained.

Wood[95] believes "that when other methods fail to cure serpiginous ulcer with hypopyon, the Saemisch section should not be employed, but Haab's iodoform discs introduced into the anterior chamber through a peripheral incision in the cornea." This plan will be found free from many objections to the old form of section, and it permits of better drainage of the anterior chamber and all of its antiseptic treatment.

Capillary drainage of the anterior chamber is advised by Rollet and Moreau[96] in the radical treatment of suppurating ulcer of the cornea. A puncture and counter-puncture in the lower part of the corneal limbus is made with a von Graefe knife. A single horse hair drain is passed through both openings. At times, it is necessary to put a hypodermatic needle in position, and insert the hair through it. The hair is left to project for some two or three centimeters' distance on each side of the cornea, and the eye is closed and dressed. They say that it is unnecessary to attempt to remove the "pus" from the anterior chamber, as it disappears within twenty-four hours' time. With this procedure, there is not any necessity for a subsequent reopening of corneal incision, and there is not any danger of prolapse of the iris. The drain is permitted to remain in position for forty-eight hours' time. Rollet[97] again refers favorably to the method.

Herbert[98] uses atropine, temporarily relieving any increased ocular tension by puncture through the base of the ulcer, or by a small subconjunctival sclerotomy. Theobald[99] recommends cauterization of simple solitary ulcer or in the early stages of spreading ulcers, with carbolic acid. He properly says, that it is "important to limit its action carefully to the affected part." To facilitate this, he analgizes the eye with cocaine, and makes the application by gently rubbing the affected area with a pointed tooth pick which is slightly charged with the cauterant.

---

[94] See Horner and Bokowa (vide the latter's article upon Hypopyon Keratitis), *Inaugural Dissertation*, Zürich, 1871. The former author is properly of the opinion that most of the deposit is in the chambers.

[95] Wood. The *Practical Medicine Series of Year Books*, Vol. III. The Eye, Ear, Nose and Throat, December, 1902, p. 43.

[96] Rollet and Moreau. Traitement de l'hypopyon par le drainage capillaire de la chamber antérieure. *Revue générale d'Ophtalmologie*, November, 1906, p. 481.

[97] Rollet. On the Cure of Hypopyon by Drainage of the Anterior Chamber with a Horse-hair. *The Ophthalmoscope*, March, 1907, p. 134, and *Revue générale d'Ophtalmologie*, July, 1907, p. 289. Le drainage au crin de la chambre antérieure contre l'hypertomie et la douleur.

[98] Herbert. *The Ophthalmic Review*, November, 1901.

[99] Theobald. *The American Journal of the Medical Sciences*, June, 1902.

In hypopyon keratitis, Zirm[100] employs a wire gauze cataract mask (as less likely to confine the discharges), combined with atropine, the electric cautery, and moist heat. He permits his patients to go about, believing that rest in bed has a tendency to interfere with the metabolism of the body in general. He makes use of sublimate vaseline instead of irrigation with bichloride of mercury solutions. He dusts the ulcer with xeroform powder. (Wood[101] prefers Airol).

In accordance with Berry[102], the treatment should be directed to first destroying the area of infiltration and then applying antiseptics. "The most convenient, as well as the most efficient way in which the first indication is complied with, is to carefully burn down the marginal infiltration with the thermo- or galvano-cautery, whenever possible." He believes[103] that the "operation is now very seldom required if the thermo-cautery be properly used."

Combined Transverse Keratotomy [104].

Chevallereau recommends this method of operative procedure in cases of definitely lost or deformed eyes over which it is desired that artificial eyes may be successfully worn without discomfort or danger. He employs the method in cases of buphthalmos, absolute and secondary glaucoma, and in corneal staphyloma.

(Although such a plan has never seemed rational or safe to the writer, yet it is here given as merely explanatory of the necessary operative details to be pursued.)

The cornea is transversely cut through its entire width, and the iris and crystalline lens are removed without any injury to the more deeply placed choroid and retina.

The eyeball gradually shrinks, though retaining its rounded form, and the cornea, though smaller, becomes well curved, thus making an excellent and freely mobile stump over which to place a glass shell. It is well not to attempt to insert an artificial eye into the conjunctival sac until several weeks have elapsed after the procedure.

Operations for Conical Cornea. (Keratoconus.)

The operative treatment of this condition has been extensive and varied, but, unfortunately, without certain success in all cases. Among the procedures the creation of an artificial pupil by either an iridectomy or an iridodesis, iridotomy, and the production of cicatricial contraction

---

[100]Zirm. Beitrag zur Behandlung der Hypopyon Keratitis. *Centralblatt für praktische Augenheilkunde*, March, 1902, p. 77.

[101]Wood. *The Practical Medicine Series of Year Books*, Vol. III., December, 1902, p. 43.

[102]Berry. *Diseases of the Eye*, 1889, p. 77.

[103]Berry. *Diseases of the Eye*, 1889, p. 617.

[104]Chevalleau. La Kératotomie transversale combinée. *Bulletins et mémoires de la Société française d'Ophtalmologie*, 1905, p. 225.

of the conic apex by excision of circular areas and ellipses of tissue and cauterization, and removal of the crystalline lens may be mentioned.[105]

As early as 1810, Ware[106] "repeatedly discharged the aqueous humor, and endeavored afterwards, by moderate pressure, to prevent the return of the projection."

In order to neutralize the increased refractive error produced by the conicity of the cornea, Adams removed the crystalline lens.[107] He spoke of the inefficiency of paracentesis. Tyrrell[108] discusses Adams' method in the following words: "It was thought that the removal of the crystalline lens, by getting rid of that convex and highly refractive body, would afford better vision in such cases; but the practice has not, in the least degree, supported the theory; for it does no good." Pickford[109] also deprecates its usefulness. On the contrary, Delafield, in his American edition of Travers' work[110], gives an interesting account of a young man who applied at the New York Eye Infirmary "with both corneæ conical and a cataract in one eye." The cataract was removed, and the patient could see much more distinctly with the eye operated upon than with the other, assisted by a concave glass of any degree. In his comments upon this case, he says, "The case tends somewhat to prove the propriety of the plan recommended by some surgeons of removing the lens in cases of conical cornea, in order to compensate for the increased refracting power of the cornea." Beard[111] has had occasion "to cause removal of the lenses in a case of high myopia and conicity of the cornea by a series of discissions. The treatment consisted in incising the capsule through puncture at the base of the cornea—done with a Graefe knife, the use of atropine, and bandaging. The duration of treatment for each eye was about six months. There were three discissions in each, a good deal of reaction

---

[105]In view of the present status of the study of the effect of the internal secretions upon the body as given by Sajous of this city (see his many works upon the subject), and the evident inadequacy of radical measures, are we not more justified in Pickford's imperfect belief (Pickford—On Conical Cornea, 1844, p. 33), that conical cornea is dependent "upon faulty action, induced by debility of the nerves of the cornea or its absorbent vessels, calling for an increased deposit from the nutrient capillaries, to repair the mischief arising from such faulty action"? He therefore submits "the probability, in the disease under consideration, of gastric or intestinal disturbance or irritation, inducing, through the medium of the par vagum, sympathetic and ciliary nerves, faulty action of the absorbent and nutrient vessels of the cornea, the combined effect of which would be conical cornea".

[106]Ware. *Observations on the Treatment of the Epiphora or Watery Eye*, 1818, p. 272.

[107]Adams. *The Journal of Sciences and the Arts*, 1817, II, p. 403.

[108]Tyrrell. *A Practical Work on the Diseases of the Eye*, 1840, Vol. I., p. 277.

[109]Pickford. On Conical Cornea, 1844, p. 12.

[110]Travers. *A Synopsis of the Diseases of the Eye*, 1825, (First American Edition), pp. 311 and 312.

[111]Beard. *Ophthalmic Surgery*, 1910, p. 389.

following the second and the third. The ultimate flattening of the cornea was truly remarkable. The best vision with glasses before the operations, etc., was 20/70, both eyes; the best after the year's treatment 20/30+ both. Here the annulment of the myopia, which had been 24 and 26 diopters, would account for most the added sight, "but I attributed (he says) much of it to the reduction of the cones." Adams' second case[112] was somewhat like this one of Beard.

Middlemore[113] speaks of the value of the creation of an artificial pupil near to the margin of an opaque cone.

Flarer[114] carried a filiform seton through the cone, hoping, by the gradual escape of the aqueous humor, to obtain its effacement.

Tyrrell[115] altered the position of the pupil so as to be opposite that portion of the cornea which had undergone the least change. To accomplish this, he made a puncture through the outer and lower part of the cornea close to the junction of the sclerotic, by the aid of a broad needle. Through this opening a small blunt hook was introduced, and the pupillary edge of the iris was caught and carefully drawn through. As much as was necessary to make an artificial pupil was excised from the iris, close to the wound. He found that "in no instance has any evil followed beyond the slight degree of inflammation, necessary to repair the mischief, occasioned by the operation."[116] While this may be so, and vision was bettered by exclusion of the peripherally placed rays of light, it must not be forgotten that in some cases there must be a marked increase in corneal astigmia. To obviate this, Bowman[117] had recourse to a double iridodesis: the incision for the second procedure being made in the sclerotic, some eight or ten days after the first, in order "to obtain the normal plane of the iris."

Favio[118] resorted to the excision of a V-shaped flap at the summit of the cone without the application of sutures.

Bader[119] states that he obtained favorable results from excising an elliptical piece of the apex of the cone. This he did by transfixing the apex of the cone with a von Graefe cataract knife and cutting from within outwards, thus producing a small flap which was held in position

---

[112]For a brief description of same, see footnote on page 536 of Volume I. of Middlemore, *A Treatise on the Diseases of the Eye*, 1835.

[113]Middlemore. *A Treatise on the Diseases of the Eye and Its Appendages*, 1835, Vol. I., p. 538.

[114]Panas. *Traité des Maladies des Yeux*, 1894, tome 1, p. 287.

[115]Tyrrell. *A Practical Work on the Diseases of the Eye*, 1840, Vol. I., p. 278.

[116]Ibidem, p 279.

[117]Soelberg Wells. *A Treatise on the Diseases of the Eye* (Fourth American Edition), 1883, pp. 250 and 251.

[118]Favio. Memoriale della medicina contemporanea, 1839.

[119]Bader. Treatment of Conical Cornea by Removal of the Top of the Cone. *The Lancet*, 20th January, 1872, p. 73.

by an iris forceps and was excised with a pair of scissors. No sutures were necessary. If the incision be made correctly, a lanceolate opening into the anterior chamber, the edges of which coapt so as to fill in the entire space, will be obtained. The pupil must be widely dilated before the operation is commenced and must be kept so, during the after-treatment. Care must be taken that too large a piece of corneal tissue is not removed. (He formerly "transferred the apex of the cone with a small curved needle carrying a suture"[120]). The eye was bandaged.

Both Galezowski[121] and Despagnet[122] speak well of the Bader plan. In regard to this question, Noyes tells us[123] that it "has been proved that the effects of prolapse of the pupillary portion of the iris are far less important than of its peripheral parts. Moreover, as the prolapse takes place near the center of the cornea the drag on the iris is a minimum. Care must, however, be taken (he warns us), to render the prolapse as small as possible, because if large, it may cause mischief." His own preference is "for excision of a small piece and uniting with sutures."

The chief disadvantage of this operation is (as Wells says[124]) "that it often leaves a very extensive adhesion of the iris to the cicatrix, which may not only impair the acuity of vision, but prove of subsequent danger to the eye, in the same way as ordinary anterior synechia." The author of the operation, however, insisted that if the wounds were placed inside of the corneal limbus, there would not be any injurious after-effects from the procedure.

Badal[125] attempted to obtain a more rapid coaptation of the edges of the corneal wound by the use of horsehair sutures which had been set into position before excision of the flap, thus tending to prevent prolapse of the iris with the formation of anterior synechia. Noyes'[126] experience has been that excision of the apex by a Graefe knife and scissors and a drawing of the wound together by fine sutures, is a very delicate but feasible procedure. He states that the stitches must be the finest filaments obtained by unraveling twisted silk, and the curved needles both very small and sharp made expressly for the purpose.

---

[120]Bader. Report of the Fourth International Ophthalmological Congress, 1872, p. 30.

[121]Galezowski *Bulletins et mémoires de la Société de Chirurgie de Paris*, 1886.

[122]Despagnet. *Archives d'Ophtalmologie*, Jan.-Feb., 1891, p. 89.

[123]Noyes. *A Textbook on Diseases of the Eye*, 1894, p. 422.

[124]Wells. *A Treatise on the Diseases of the Eye* (Fourth American Edition), 1883, p. 252.

[125]Badal. Trois Cas de Kératocone. Résultats immédiats et éloignés des Interventions chirurgicales. *Archives d'Ophtalmologie*, XXI., p. 433.

[126]Noyes. *A Textbook on Diseases of the Eye*, 1894, p. 422.

The whole corneal tissue is included and the stitches must come out in two days. There need be no prolapse of iris, and the scar may be very small.

Silcock[127] reports a case of conical cornea in which an elliptical wedge-shaped piece was removed from the apex of the cone by means of a von Graefe knife, the long axis of the wedge being placed at right angles to the meridian of highest refraction. Five and a half years after the operation, vision was brought to normal by aid of high minus cylinders with their axes placed obliquely. The original (possibly uncorrected) vision equaled one-tenth.

A case of successful excision of the apex of a conical cornea has been reported by Stauffer.[128]

For the better, the easier, and the more perfect excision of the elliptical piece of cornea, Critchett made use of an ingenious knife which consisted of two Sichel blades so arranged that they could be set at any required angle of excision. His ordinary operation of iridodesis was performed as follows: A small incision was made with the help of a broad needle through the marginal portion of the cornea at the point selected, and a noose of thread laid on the cornea surrounding the opening. A canula-forceps was passed through the loop and through the wound. The iris midway between the ciliary and pupillary margins was seized at about one-third way from the latter margin, and drawn out of the eye and secured by tying the loop.[129]

To relieve the engagement of the iris and the corneal wound which had been so fatal to the ordinary "iridodesis" plan of Critchett, Bowman[130] employed a modification of the method for the relief of the condition by the making of a double "iridodesis." He withdrew the pupillary border of the iris by means of fine hooks, converting the pupil into narrow slits which gave a marked betterment of visual result and seemingly had a beneficial influence upon the lessening of the corneal bulge. The shapes of the slit-like pupils can be better regulated by the double iridodesis plan made in opposite directions. He found that a vertically disposed pupil appeared to better advantage.

The accompanying diagrams exhibit the appearances of the pupils during dilation and contraction of the horizontal slit, the vertical one, and the balloon-shaped one.

---

[127]Silcock. Conical Cornea. *Transactions of the Ophthalmological Society of the United Kingdom*, 1893, p. 56.

[128]Stauffer. A Successful Operation for Conical Cornea, with Report of a Case. *The Ophthalmic Record*, May, 1906, p. 205.

[129]Critchett. *Ophthalmic Hospital Reports and Journal of the Royal London Ophthalmic Hospital*, 1858, Vol. I., p. 220-225; Vol. II., p. 145; and Vol. IV, p 156

[130]Bowman. *Ophthalmic Hospital Reports and Journal of the Royal London Ophthalmic Hospital*, 1859-1860, Vol. II.

Stellwag[131] states that the application of the ligature to the protruded portions of the iris, in either Critchett's first or second operation, is obtained only after the greatest difficulty. This complication the writer has seen while witnessing the procedure.

The immediate and the remote risks of both operations as regards inflammatory reaction of the iris and transference of inflammation to the opposite organ, however, have prevented their general employment.

Von Graefe[132] cauterized the conic apex which had been superficially scarified with a cataract knife. Care was taken that the membrane was not penetrated. After a period of a few days, the floor of the gap was lightly and repeatedly touched at several points with a crayon of mitigated nitrate of silver, followed by immediate neutralization. There was little or no reaction, the flattening of the resultant scar bettering the curvature of the cornea. In some cases the aqueous

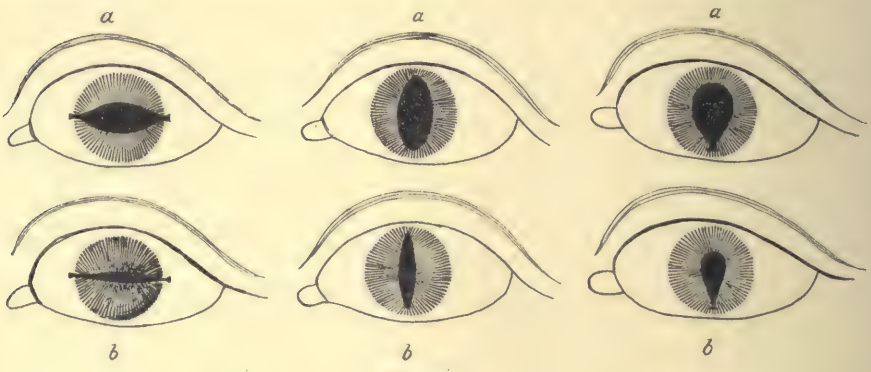


Fig. 462.
Dilation and Contraction of Artificial Pupil in Conical Cornea.

humor was evacuated by a paracentesis, made every few days for three or four times. A bandage was worn until the healing process had fairly well taken place. This, which led to the formation of a dense conical opacity, was followed, when necessary, by the making of a narrow optical iridectomy. Trélat[133] modified this plan by making the eschar at the periphery of the cornea, permitting the iridectomy to be better made at the opposite side of the membrane.

Meyer[134] prefers the method of von Graefe, except that he removes a portion of the cone of about three millimeters in length just to the

---

[131]Stellwag von Carion. *Lehrbuch der praktischen Augenheilkunde*, 1867, S. 259.

[132]von Graefe. Zur Heilung des Keratocomes. *Archiv für Ophthalmologie*, XII., p. 215.

[133]Trélat. *Bulletins et mémoires de la Société de Chirurgie de Paris*. 1875.

[134]Meyer. *A Practical Treatise on the Diseases of the Eye*. (English Translation by A. Freeland Fergus), 1887, p. 149.

outside of its summit, taking care, as in the von Graefe operation, to avoid penetrating the anterior chamber. For this purpose, he has devised a special needle, the shape and size of which is shown herewith.

Having abandoned the Graefe method of the application of caustic to the abraded surface by reason of prolonged irritation, Bowman, in 1869, employed drills for excision of a portion of the cone. They were constructed on the same principle as a Heurteloup artificial leech. The instruments varied in diameter, and were provided with a movable "stop" to regulate the depth of penetration.[135] They were rotated by the finger and thumb.

Later[136], he carried the trephined area merely down or just in front of the membrane of Descemet. The corneal flap was seized with a pair of fine forceps and dissected free with a broad needle. Later, the bulging floor of the abraded area was punctured at its center (or a small portion of it excised), thus allowing temporary drainage of the aqueous humor through the part of the cornea which could not be reached by the iris tissue, and preventing the formation of any anterior synechia. The opening was kept free by repeated paracenteses until

Fig. 463.
Meyer's Needle for the Operation in Conical Cornea.

all conicity had disappeared. He states that the "opacity resulting from this mode of operating seems to be unexpectedly slight, but if required, it may be concealed by the tattooing process."[137]

De Wecker and Warlomont also employed corneal trephines.[138] The former's instrument was intended to make a fistula in a cicatrix, "which is usually very thick, and opposes considerable resistance." It was provided with a spring by which an instantaneous rotation was produced, "and during the rotation there is a retiring of the cutting edge from the cut surface."

Abadie[139] placed the cauterization area more towards the periphery

---

[135]Bowman. *Report of the Fourth International Ophthalmological Congress*, 1873, p. 181.

[136]Bowman. *Report of the Fourth International Ophthalmological Congress*, 1873, p. 182. Stephenson (The Ophthalmoscope, June, 1910, p. 415) has modified this trephine to advantage by adopting the Argyll Robertson device of a handle, and having the instrument made from solid steel and drilled. "It carries a collar bearing pin, which fits into the slot of the pinion-wire handle, and thereby prevents the latter from rotating. The handle is fixed by a nut which screws on to the proximal end."

[137]Wells. *Treatise on the Diseases of the Eye* (Fourth American Edition), 1883, p. 252. (Personal communication to the author.)

[138]De Wecker et Warlomont. *Report of the Fourth International Ophthalmological Congress*, 1873, p. 183.

[139]Abadie. *Thèse de Guiot*, 1887.

of the cornea. He did not penetrate more deeply than Descemet's membrane. Sichel[140] excised the conic tip down to Descemet's membrane, followed by touching the operated-upon area with the mitigated stick and the actual cautery. When healing had occurred, recurrent paracenteses in order to produce and to maintain a fistula in the hopes of further flattening the cornea were made.

Andrew[141] uses the actual cautery over the scarified area. Robert D. Gibson[142] penetrates the cornea with the galvano-cautery. He reports good results. Gayet[143] has also made use of the penetrating effect of the cautery in such cases. Repeated cauterization with permanent marked improvement of vision has been successfully done by Schwenk [Pennsylvania Medical Journal, August, 1907]. Ziegler [Pennsylvania Medical Journal, August, 1910] is of the opinion "that corneal perforation is requisite to success."

The galvano-cautery has been employed by Dodd[144]. He makes a series of cauterization points at about a millimeter's distance apart around the apex of the cone. The side towards the pupillary center is not touched. He recommends repetition of the procedure if necessary As Grimsdale and Brewerton[145] say, "This method seems effective, and, inasmuch as the central zone of the cornea is untouched, the necessity for after iridectomy is reduced. The scar, however, does not support the weakest area (the center or apex of the cone), and it would seem more liable to an extension of the disease." Del Toro[146] destroys the vertex of the cone by a fine knife heated to a white heat, two weeks after having made an iridectomy, believing that the cauterization which leaves but a slight opacity, exercises a beneficial influence on any existing keratomalacia, and that the iridectomy tends to diminish any tendency towards increase of intraocular tension.

Swanzy[147] tells us that "Multiple puncturings of the apex of the cone with a fine cataract needle have been employed." The summit of the cone is transfixed from three to six times at each sitting; this may be repeated at intervals of two weeks or more. The first effect of the punctures is to allow some of the aqueous humor to escape. The eye is firmly supported with a bandage, and the pupil is kept under the influence of eserine. "Eventually, a network of cicatricial tissue forms,

---

[140]Beard. *Ophthalmic Surgery*, 1910, 387.

[141]Andrew. On the Use of the Cautery in Eye Practice. *British Medical Journal*, 1884, II., p. 903.

[142]Fox. *A Practical Treatise on Ophthalmology*, 1910, pp. 232-233.

[143]Gayet. *Lyon médicale*, XXX., 1879.

[144]Dodd. Operation for Conical Cornea. *The Medical Press and Circular*, February, 1903, p. 171.

[145]Grimsdale and Brewerton. *A Textbook of Ophthalmic Operations*, 1907, p. 333.

[146]Del Toro. *La Cronica Oftalmologica*, 1881, 12th May.

[147]Swanzy. *A Handbook of the Diseases of the Eye*, 1903, p. 176.

which flattens the cone without giving rise to much corneal opacity." Higgens'[148] plan has been modified as follows, by Morton: In the words of Swanzy,[149] "He excises an elliptical piece from the apex of the cone by transfixing it from above downwards, about midway between its base and apex with a long narrow rigid Graefe knife, of which the edge is directed forwards and inclined slightly to the right. The knife is pushed onwards until it cuts its way out a little to the right of the apex of the cone, the aqueous escaping at the same time. The flap thus formed is then lifted up well by a fine forceps, and the knife—with its edge now turned to the left—is passed beneath the points of the forceps, and by cutting forwards, the flap is excised. The sides of the wound should be steep and incline towards each other at an angle of 30° to 45°. The apex of the cone being somewhat downwards and inwards, or outwards, from the center of the cornea, it is important, in order to prevent an anterior synechia, to avoid carrying the incision too far downwards. The eye should be well soaked with atropine both before and after the operation." A firm compress must be kept on for some time after the wound has healed.

Morton[150] repeatively excises the apex of the cone. If there is any increase of intraocular tension, or if any disturbing optical conditions be present, he makes use of an iridectomy. He has also practiced synechtomy and paracentesis of the cornea to advantage. His results with the cautery have been generally associated with perforation of the membrane. Swanzy[151] teaches that a satisfactory proceeding is the application of the electro- or thermo-cautery at a red heat to the apex of the cone. He says that the operation is practically free from risk. The cauterization must be confined to a small area at the apex of the cone and the cornea should not be perforated with the cautery. The operation, he states, may be repeated over the same area at intervals of ten to fourteen days, "to bring about a more intense cicatrix."

A. Critchett[152] lays much stress on the graduated application of the cautery. He first applies the cautery at a black heat to the whole area of the cornea intended to be cicatrized; within this area a little more is destroyed at a slightly increased heat; while the very apex is touched with a cautery at a dull red heat. One sitting, he tells us, is sufficient.

Tweedy[153] pushes cauterization so far as to produce perforation "which he believes is essential to the production of a flattened cicatrix, and is without danger.

---

[148]Higgens. *The British Medical Journal*, 1880, p. 623.
[149]Swanzy. *A Handbook of the Diseases of the Eye*, 1903, p. 176.
[150]Morton. *The British Medical Journal*, 26th September, 1903.
[151]Swanzy. *A Handbook of the Diseases of the Eye*, 1903.
[152]Critchett. Conical Cornea, Its Surgical Evolution. *Practitioner*, 1895, p. 426.
[153]Tweedy. *System of Diseases of the Eye*, Norris and Oliver, Vol. II., p. 252.

Herman Knapp,[154] speaking of the value of the galvano-cautery in keratoconus, states that his experience coincides with that of A. Critchett and Tweedy. Like Critchett, he grades his degree and areas of burning. He employs convex disc electrodes applied directly to the parts. (See Figure). The largest area is superficially burnt the most; the middle zone is burnt to a less degree; while the central portion is burnt the least.

The burning, which when done properly and carried to perforation, is seldom, if ever, necessary to repeat. One-half of the pupillary area should, if possible, be spared. The best results, he finds, are obtained in the early stages of the progressive types of the disease. In regard to his experience with the use of cauterization, he gives the following interesting happening:[155] "At first I used a pointed burner, and pierced the cornea freely. The recovery was tedious, but the result perfect and permanent. Then I made the cauterization very cautiously and pierced the cornea so slightly that the aqueous did not jet, but oozed out. This took a longer time, and was followed in from six to eight weeks by the formation of a peculiar-looking yellowish

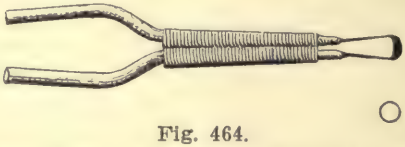


Fig. 464.
Galvano-Cautery Burner for Conical Cornea.

cataract (the patient was fourteen years old). The wound healed well, I extracted the cataract later, and the eye has had good sight ever since, eight years. I have always considered this cataract as due to the overheating of the aqueous humor during the cauterization, for I had never seen such a peculiar-looking cataract apart from its developing in a young and healthy eye."

Panas[156] also indorses the experience of Critchett and Tweedy.

The apex of the cone is not burnt by Sgrosso[157]. He makes as solid a cicatrix as possible—one which is able to resist intraocular pressure. To do this, the cautery point is applied to the temporal wall of the cone, and the burning is made as deep and as extensive as is safely possible.

Cauterization without perforation has been, in the hands of Wicherkiewicz,[158] the most satisfactory method of procedure.

---

[154]Knapp. *Archives of Ophthalmology*, 1892, p. 40.
[155]Knapp. *System of Diseases of the Eye*, Norris and Oliver, Vol. III., p. 824.
[156]Panas. *Traité des Maladies des Yeux*, 1894, p. 293.
[157]Sgrosso. *Annali di Ottalmologia*, XVIII., 3, 1900.
[158]Wicherkiewicz. Quelques considerations sur le Kératocone primaire. *Archives d'Ophtalmologie*, February, 1905, p. 87.

Wolfe's[159] plan is to tint over the cone and thus produce an opacity of the distended portion. He then makes a small artificial pupil in order to allow the rays of light to enter through the part of the cornea of more normal curvature. Grandclément[160] speaks of tattooing, not only as a cosmetic procedure for corneal opacities, but also as a curative measure in conical cornea: In the latter type of cases, Gayet[161] attributes the happy results to the scarifications that are made.

Elschnig,[162] believing that one of the requisites for success in the surgical treatment of keratoconus, is the prompt vascularization of the cauterized area, superficially burns the cone, which is generally eccentric, with a galvano-cautery at a dull redheat. He connects the cauterized area with the nearest point on the conjunctival limbus by a superficially burned band of the same width as the burnt corneal area. In several days' time, the bridge of superficial cauterization will become vascular, until in a couple of weeks' time, the cauterized area will be filled with many vessels. If the case is an almost centric one, the burned area should be placed to the side which is nearest to the corneal limbus. He does not think an optical iridectomy is necessary, and asserts that it may even prove harmful. In some cases he tattooes the after-opacity in order to prevent diffusion of light. He is daily on the watch for betterment of both local measures and systemic treatment.

Sattler[163] finds that the best surgical methods are the galvano-cautery as supplemental to iridectomy or iridotomy. In desperate cases he makes use of extraction of the lens, followed by superficial cauterization of the apex of the cone or corneal tattooing. He advises caution in the performance of any form of operative procedure, as it is usually tedious, and in the most favorable cases, is associated with danger and uncertainty.

Beard[164] states that if no progress is obtained by other than radical measures, "repeated paracentesis of the cornea is subjoined, to which might, as an ulterior measure, be added the application of a small galvanic tip, in three or four short meridional lines, near the base. "If these measures failed of material improvement, I (he writes), should still advise against more drastic surgical treatment save where the ectasia is very great and the vision very poor, so poor, indeed, as hardly to be called useful." He justly adds: "True, much depends upon the fellow eye. If this be possessed of fair sight, one may venture further."

---

[159]Wolfe. *On Diseases and Injuries of the Eye*, 1882, p. 85.
[160]Grandclément. *Lyon médical*, 2nd March, 1891.
[161]Gayet. Ibidem.
[162]Elschnig. *Wiener Klinische Rundschau*, 15th May, 1904.
[163]Sattler. *The Journal of the American Medical Association*, August, 1900.
[164]Beard. *Ophthalmic Surgery*, 1910, p. 389.

As mentioned by Soelberg Wells[165]: "At present it must be admitted that all these modern methods of treatment of conical cornea are still upon their trial, and nothing decisive can as yet be said as to their relative advantages and disadvantages." As then, so now! Though this is so, the writers cannot share the pessimistic views of Lawrence,[166] who, in the light of his day, said: "If we do not know the cause of the affection, we cannot be prepared to propose any rational treatment. I cannot say that I have seen any plan productive of benefit."

At the time of writing (June, 1910) this present chapter, the author has reason to be deeply impressed with the importance of careful and repeated correction of the refractive errors and the employment of suitable discs in such cases in spite of the diminished field of vision and decreased illumination; limiting his operative work to those few instances which cannot be apparently bettered in any other way, and choosing that form of procedure, which seems to be the best adapted in each individual case.

OPERATIONS UPON CORNEAL STAPHYLOMA.

When the imperfectly termed condition of *staphyloma corneæ*[167] is partial and but slight, it is to be met surgically as nearly as possible. Compression, ligation, cauterization, incision with pressure, and excision, are among the best-known radical measures that have been adopted for its removal. If the partial type be fresh and larger, iridectomy, either opposite the most transparent portion of the cornea or so situated in favorable cases, in positions to get rid of disturbing anterior synechia, in connection with abscission, and cauterization, are better adapted to meet the requirements in each particular case. In the coarsest and grossest partial types, the protuberant mass must be opened, freed of its contents, and thoroughly cleaned to the floor of the sac; any fistulous communications with the eyeball proper being carefully cauterized.

Enucleation is the only remedy when intraocular tension has become permanently or even intermittingly increased in spite of the performance of the minor procedures such as incision, excision, or avulsion of the iris *(iridavulsion)*,[168] as practised by Noyes.[169]

---

[165]Soelberg Wells. *A Treatise on the Diseases of the Eye* (Fourth American Edition, Edited by Charles S. Bull), 1883, p. 253.

[166]Lawrence. *A Treatise on the Diseases of the Eye*, 1844, p. 370.

[167]For an excellent description of this condition and its naming, consult Ritterich-*Die Hornhautbeere*, "*Staphylom der Hornhaut*," 1859; For an exhaustive exposition of the subject from all standpoints, the reader cannot do better than read "*Ueber das Staphylom der Hornhaut*, von Dr. Franz Chelius, published in Heidelberg in 1847; For good graphic representations of the intercalary and racemose types of the disease, see Vossius' "*Das Staphylom der Cornea und Sclera*," 1895.

[168]Noyes. *A Text-Book on Diseases of the Eye*, 1894, p. 417.

[169]Ibidem, p. 460.

On the contrary, Beer[170] states that he has successfully removed more than two hundred staphylomata by operation, without any dangerous complication.

This plan of treatment of beginning staphylomata from both traumatism and penetrating chronic inflammation of the cornea, is quite old. The compresses, which were graded, are said by both Wenzel and Ware[171] to be inconvenient and useless.

While this may be so, for the compresses alone, yet the present writer, through the kindness of one of his colleagues at Wills' Hospital, Dr. Paul J. Pontius, has had opportunity to see several cases of beginning staphylomata in young subjects, successfully treated by Dr. Pontius and to treat some personally, by the local use of various strength solutions of thyroid extract combined with the employment of a constant compress bandage.[172]

Among the best known of the simplest radical procedures is that employed by Woolhouse[173] for the reduction of herniaed irises following cataract extraction. He termed the method *emboitement.* He used a metallic instrument so constructed as to fit over the eye. After oiling its convex and concave sides, he introduced it under the eyelids in such a manner that it might press the tumor on the cornea.[174]

Platner[175] depicts an instrument for the same purpose.

Similar contrivances have been uselessly and even dangerously employed since.

Treatment of Staphyloma Corneæ by Ligation and Seton.

The operations by ligation and seton are very old ones, dating back to the times of the ancient authors, Celsus,[176] Paulus Ægineta,[177] and others, advised the carriage of a double-threaded needle through the base of the mass. Each suture was tied to the side of the projection, thus leaving an intervening ligatured area to slough away and cicatrize. Ætius[178] made use of two needles placed at right angles to

---

[170]Beer. *Lehre von den Augenkrankheiten,* 1817, II, S. 216.

[171]Wenzel and Ware. Loco citato, p. 243.

[172]Dr. Pontius is at present (June, 1910), preparing a clinical paper upon the subject.

The reason for the brilliant results in these cases are highly interesting from the present day pathology of internal secretions. (*Vide* views of Sajous and Pickford given in foot note 105).

[173]Wenzel, Jr., *A Treatise on the Cataract* (English Translation by James Ware, 1791), p. 241. (Also see pp. 349 and 350, Le Cerf, Dissertations Scavantes et Critiques de Monsieur de Woolhouse . . . . sur la Cataracte et le Glaucoma, 1717.

[174]Mauchart. *Dissertatio de Staphylomate,* Tübingen, 1748.

[175]Platner. Inst. Chir. 1783, Tab. VI., Fig. 13.

[176]Celsus de Re Medica, Lib. VII., Pars. II., Cap. I., VII., Sect. 2 ("in summâ parte ejus ad lenticulae magnitudinem exscindere").

[177]Paulus Æginetus. Encheirid, Lib. VI., Cap. XIX. (Morbis oculorum).

[178]Aetius. Tetrabibl, 2, serm. III., Cap. 35, p. 343.

one another. For the removal of partial staphylomata, de Saint Yves[179] lucidly and quaintly tells us "I take an EDGED NEEDLE, somewhat crooked, threaded with Silk. I pass it through the middle of the STAPHILOMA; when the SILK is run through, I withdraw the NEEDLE, and, holding both Ends of the SILK with my LEFT HAND, twist them a little; afterwards with a Lancet, I cut theTumor in its Basis below the SILK, and, with one Nip of my SCISSARS, I take it off intirely."

In 1841, Furnari[180] stated that use of the seton recommended by the ancients, was generally abandoned in his day by reason of the accidents which it produced. Roux[181] employed it in 1827.

Borelli[182] made use of two pins inserted at right angles with one another, as shown in accompanying figure. Beneath them, he passed a strong piece of silk so as to forcibly compress them together, thus

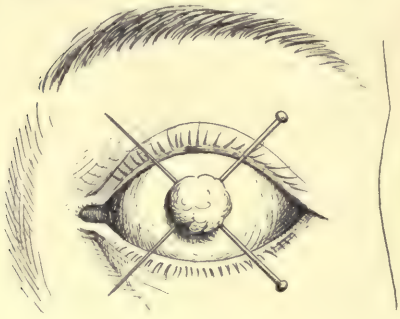


Fig. 465.
Implantation of Pins in a Staphyloma. Borelli.

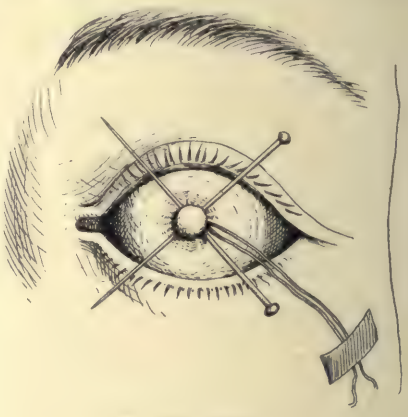


Fig. 466.
Application of Ligature to a Staphyloma. Borelli.

strangulating the mass, as shown in figure 466. A compress bandage placed over English taffeta was applied. He reports that cure took place very quickly and that it lasted for many years.

Middlemore[183] cannot recommend the double ligature for the cure of staphyloma "for it is painful, tedious, and, in some instances, as regards its effects, an ineffectual mode of procedure."

---

[179]de Saint Yves. *A New Treatise of the Diseases of the Eyes*, English Translation, 1741, p. 205.

[180]Furnari. *Traité Pratique des Maladies des Yeux*, 1841, p. 309.

[181]Roux. *La Clinique* (La Clinique des Hôpitaux et de la ville), 8th Jan., 1828.

[182]Borelli. Compte rendu du Congrès d'Ophtalmologie de Bruxelles, 1857, p. 438.

[183]Middlemore. *A Treatise on the Diseases of the Eye and Its Appendages*, 1835, Vol. I., p. 520.

Ware[184] operates as follows: It is practically a very old one.[185] A curved needle with a strong thread is passed through the opaque projecting cornea, and after separating the needle from the thread, a knot is tied in the latter, at a small distance from the eye, in order to hinder the thread from slipping. The operator having

"thus obtained by means of the thread a secure hold of the eye, a knife similar to that which is used to divide the cornea in extracting the cataract, or, if this be not at hand, a long sharp-pointed lancet should be pushed through the sclerotic coat, about a quarter of an inch from its connection with the cornea, and be carried quickly, but accurately, round the cornea, as nearly parallel to it as can be accomplished. Sometimes, as soon as a puncture is made through the sclerotica, so large a portion of the vitreous humor escapes as to cause the cornea to become flaccid; in consequence of which the operator may find it difficult to complete the incision round this tunic with either the lancet or the knife; and in this case a curved blunt-pointed scissors will be found useful to finish the operation. The only objection to the use of the scissors is drawn from the additional pain which it is supposed to give; but the duration of the operation is so short that the difference between the pain produced by the instruments is scarcely worthy to be named. The hemorrhage that succeeds is seldom considerable; and the less the eye is examined afterwards, the less danger will there be of pain and inflammation. A compress wet with a saturnine lotion should be applied over the eye, and it should be moistened with this liquor, without being removed, as often as it becomes dry; but no lint or any other application should be put within the lids, since this has been known to give great pain, and in one instance to occasion alarming symptoms. An anodyne should be given after the operation, of greater or less strength, according to the age of the patient; but it is seldom necessary to repeat this medicine, since the patient has usually more sound and quiet sleep after the operation than he had for a long time previous to its performance. At the end of about a fortnight that part of the sclerotica which remained in the orbit will be found to have collapsed, and sometimes a small fungous substance will then protrude through the wound. This in the course of time would subside of itself; but as the delay may be irksome, the fungus may be easily removed, and with very little pain, by snipping it off with a pair of sharp scissors. The fungus is usually smaller in its neck, where it joins the sclerotica, than in its top; in consequence of which its removal is effected with very little difficulty; and though it sometimes reappears, it may be snipped off again and again, until at length the wound will completely close, the inflammation cease, and the orbit become fit to receive an artificial eye."

In a clinical observation of a case of secondary staphyloma of the cornea from ulceration, Fieuzal[186] cites the good results from an operative procedure which arose from ocular drainage with cessation of pressure symptoms and rapid decrease of inflammatory reaction, secured by the aid of the insertion of a seton of a thin gold thread.

Cauterization of Corneal Staphyloma.

In recent years, Richter[187] produces "an artificial ulcer upon the base of the tumor of the cornea, by means of the reiterated application

[184]Ware. On the Staphyloma, Hydrophthalmia, and Carcinoma of the Eye. *Observations on the Treatment of the Epiphora, or Watery Eye*, 1818, p. 279.

[185]See de Saint Yves. *A New Treatise of the Diseases of the Eye*, English Translation, 1741, p. 204.

[186]Fieuzal. *Fragments d'Ophtalmologie, Clinique de l'Hospice des Quinze-Vingts*, 1880, II., p. 368.

[187]Richter. *Observationes Chirurgicae*, Fasciculus II.

of the argentum nitratum of the antimonium nuriatum," and keeps it open by the repeated use of these caustics. He mentions a "cure" by this method in fourteen days' time. Scarpa[188] says that he is "sorry to be obliged to declare that although he had frequently adopted this method of treatment in the recent staphyloma of infants," he had "never had the gratification to obtain such success, either with regard to restoring the transparency of the cornea; or diminishing the size of the staphyloma, as to be in any degree compared with that obtained and recorded by Richter." As to its use in the inveterate staphyloma of adults, he doubts whether it will be ever easy to "produce a persuasion that the same mode of treatment can ever be of utility in obtaining a diminution of the size" of such protrusions. Middlemore[189] does not believe that the application of caustic is suited to very young subjects "on account of the extreme thickness of the cornea in very early life, and the consequent difficulty of destroying the whole of the corneal lamellæ, so as to penetrate the anterior chamber."

As at present done, the operated-upon parts are to be carefully cleansed, the eye is to be lightly covered with an evenly placed and firm pressure bandage, and the patient is placed in bed. Care should be taken during cauterization to limit the main burning to those portions that should be strengthened for later cicatrization.

Incision of Staphyloma.

This operation consists in a division of the mass in the direction, as a rule, of the axis of its longest meridian. According to Fuchs[190] Küchler makes the incision transversely across the mass in total staphyloma. It is best done as shown in the figure. After the severance of the two portions[191], the aqueous humor, with or without a portion of the bulbar contents, will escape, and the walls of the mass will collapse and fall together, forming a foundation for a flattened cicatrix. The parts are to be cleansed. Atropine is to be instilled[192], and the lids simultaneously closed by adhesive strips, or preferably, a carefully applied compress bandage placed over the shut eyelids. The patient is to be placed in bed and kept quiet for a few days' time. The bandage should be changed at every bidaily or daily dressing, and must be worn until the cicatrix has become firm and strong. Demours[193]

[188]Scarpa. *A Treatise on the Principal Diseases of the Eye.* English Translation by James Briggs, 1818, pp. 402-403.

[189]Middlemore. *A Treatise on the Diseases of the Eye and Its Appendages,* 1835, Vol. I., p. 518.

[190]Fuchs. *Lehrbuch der Augenheilkunde,* 1903, S. 253.

[191]A staphyloma knife, which is merely an enlarged cataract knife, is employed by some operators.

[192]Care must be enjoined in the use of this drug in elderly subjects and in those few cases in which there is any tendency towards an increased intraocular tension.

[193]Demours. *Traité des Maladies des Yeux,* 1818, tome I., p. 320.

believes that "l'incision cruciale est bonne, et ne mérite pas d'être abandonnée." Stellwag[194] prefers adhesive strips for the closure of the lids "especially in unreliable patients, as a monocular pressure bandage is easily displaced, and is ineffectual, while a binocular one would be unbearable if worn for a length of time." Wardrop[195] gives a remarkable account of an educated patient, who, having had a spontaneous rupture of an eye affected with staphyloma corneæ, with a consequent less prominence of the eyeball, actually repeatedly punctured his cornea with a large needle, until the eyeball assumed a much better shape and became free of inflammation. Later, he rubbed the opposite eye (also staphylomatous), producing a flow of aqueous humor. Since that time, the second eyeball discharged two or three drops weekly, with immediate cessation of all pressure symptoms.

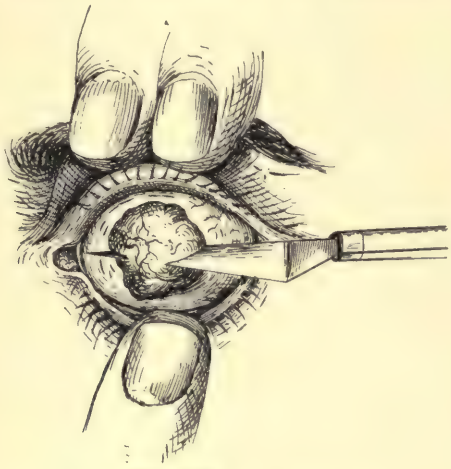


Fig. 467.
Splitting of a Staphyloma (Stellwag).

The procedure is said to be of value in thin-walled partial staphylomata which readily collapse, and in which there is but slight incarceration of the iris tissue. Should the lens be wounded, it should be immediately removed. If there is much escape of vitreous humor, or if an extensive intraocular hemorrhage appears, it is best, in most cases, to remove the organ at once, as it not infrequently becomes a source of extremely painful and ofttimes ruinous, suppurative inflammation.[196]

---

[194] Carl Stellwag von Carion. *Treatise on the Diseases of the Eye* (American Edition), 1868, p. 105.

[195] Wardrop. *Essays on the Morbid Anatomy of the Human Eye*, 1808, p. 106.

[196] For a good description of the histology of corneal staphyloma the reader is referred to page 273 of Michel, *Lehrbuch der Augenheilkunde*, 1884.

Ablation, Abscission, Excision or Staphylectomy.

Paré[197] excised the entire mass and allowed the parts to heal. Boerhaave[198] resorted to the use of ablation in the surgical treatment of *excrescentia corneæ*. Beer[199] performed abscission. He made the puncture and the counter puncture in the horizontal meridian of the mass at the base of the elongated cornea with his well-known triangular cataract knife. He directed the edge of the blade of the instrument forwards and downwards, cutting the base of the mass from out within. This done, he made a similar incision upwards with a pair of scissors, thus completing the abscission. The lens and a portion of the vitreous humor frequently escaped through the opening. It is believed by some that the procedure is peculiarly valuable in the treatment of old, thick-walled staphylomata.

In conformance with Celsus' proposition[200] to excise an elliptical-shaped area of the size of a lentil seed from the apex of the staphyloma, allowing the crystalline lens and the vitreous humor to remain, and then to have closure of the opening take place, Scarpa[201] excised a small lenticular-shaped piece of "two, three, or four lines in diameter" from the staphylomatous summit, through which, he states he forced the crystalline lens and vitreous humor; (entirely too small an opening as Ware says[202] to permit such a procedure "without forcibly compressing the iris"). Richeraud[203] and Langenbeck[204] made similar procedures.

"Staphylotomy" (he should have stated "staphylectomy" as he describes this latter operation in his communication), is said by Abadie[205] to be of exceptional value for the removal of large isolated staphylomata which have adjacent clear cornea, and are complicated by anterior synechia in shallow anterior chambers.

The clear cornea just beyond the staphylomatous area is punctured with a von Graefe knife. The incision is made so as to include the iris tissue. The handle of the knife is then depressed, and the point of the instrument is carried forward until the opposite side of the staphyloma is reached, when it is pushed through the iris and the cornea. The included iris and cornea are excised. The procedure frees the

---

[197]Beard. *Ophthalmic Surgery*, p. 390.

[198]Boerhaave. *Prælectiones Publicæ de Morbis Oculorum*, 1748, pp. 58-60.

[199]Beer. *Ansicht der staphylomatösen Metamorphosen des Auges und der Künstlichen Pupillenbildung*, 1805.

[200]*De Medicina*, lib. VII., Cap. 7.

[201]Scarpa. *A Treatise on the Principal Diseases of the Eye* (English Translation by James Briggs), 1818, p. 407.

[202]Vide Wenzel. Ware, p. 277.

[203]Ibidem.

[204]Desmarres. *Traité theorique et pratique des Maladies des Yeux*, 1847, p. 339.

[205]Abadie. Congrès international periodique d'Ophtalmologie, Copenhagen, 1884.

cornea from the constant drag of the synechia, the staphyloma flattens, and the scar heals with a consequent fairly good curvature.

In total staphyloma, Middlemore[206] operates by transfixing the center of the cornea with a pair of hooked forceps, and passing a triangular cataract knife through the whole protrusion (which in this case involves the entire cornea) midway between its center and its margin on each side, and urging it forward until it "cuts its way out" at the opposite side. The upper or lower flap is then excised with a pair of curved scissors "observing as nearly as possible the same directions with regard to the magnitude of the part excised, and the distance of the incision from the border of the cornea, as regulated (the) operations in making the lower incision." The lens, which is generally diminished in size, with a small portion of the vitreous, will be discharged. Should the lenticular capsule and its retained lens remain in their proper positions, he advises to leave them *in situ,* so as to permit the eyeball to retain a better appearance. Should any hemorrhage occur, he awaits a brief period of time before applying a bandage. Cold compresses are employed and rest in bed—particularly in cases in which there is much reaction—which is quite apt to occur—is strictly enjoined. He advises[207] excision of the summit of partial staphylomata.

Tyrrell[208], after speaking of the employment of local medication and attention to the general health in the treatment of the condition, tells us that for "complete staphyloma, nothing further can be done except by operation." The method which he describes is extremely simple—"A needle armed with a ligature or a curved cataract needle, should be passed through the staphyloma, to enable the surgeon to fix the globe, whilst he passes a pointed knife through the base of the projection, and separates it from the globe. The removal is usually followed by the escape of the lens, and a large part of the vitreous humor:" the remaining tunics, in a degree, collapse.

In performing the operation, a sufficient opening should be made, to allow of the escape of the humors; otherwise, a fresh staphyloma is likely to form. In addition, he gives the sage advice "I should not advise the operator to interfere with the sclerotic tunic, as I have observed that severe suppurative inflammation has followed, in several cases in which that coat has been divided."

Frick[209] says that in the more inveterate species of the disease, or in the *staphyloma totale,* he prefers simple and total excision with-

---

[206]Middlemore. *A Treatise on the Diseases of the Eye and Its Appendages,* 1835, Vol. I., p. 521.

[207]Loco citato, p. 526.

[208]Tyrrell. *A Practical Work on Diseases of the Eye,* 1840, Vol. I., p. 271.

[209]Frick. *A Treatise on the Diseases of the Eye,* 1823, p. 92.

out sutures. The lens and the vitreous are, if possible, left undisturbed. "The dressing and after-treatment are the same as in the operation for cataract." In regard to the treatment of partial staphyloma, he tells us "that when the disease is connected with a varicose state of the vessels (cirsophthalmia), it becomes a perfect *noli me tangere*, and any attempt to remove the deformity or blindness, is attended with an aggravation of all the symptoms."

Wilde[210] introduced a curved needle through the staphylomatous base. He then removed the mass with a cataract knife and scissors, drawing the needle through and tying the ligature.

In regard to the practice of Woolhouse[211] including the sclerotic coat in the circular division of the mass, it has been justly said that

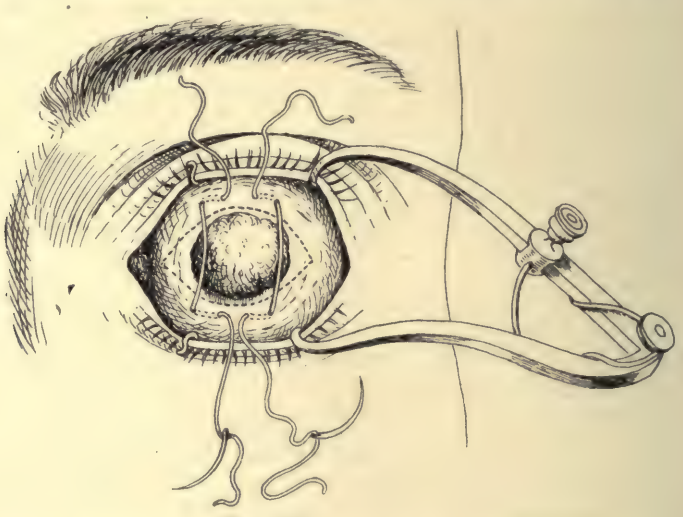


Fig. 468.

Position of Needle Punctures in Knapp's Operation for Total Staphyloma.

"such a mode of treatment is invariably followed by violent inflammation of the eyeball and eyelids, most acute pain in the head, watchfulness, convulsions, copious suppuration, and sometimes gangrene of the eye and eyelids."[212]

Knapp[213] arranges two suture threads so placed as to make them act vertically. Properly, he avoids passing them through the ciliary region. Figure 468 shows their relative positions very well.

---

[210]Wilde. *The Dublin Quarterly Journal of Medical Science*, 1847, Vol. III., p. 242.

[211]See also de Saint-Yves' operation for total staphyloma when an artificial eye is to be applied, on p. 309 of Stockton's English Translation of "*A New Treatise on the Diseases of the Eye*," 1741.

[212]Vide de Saint-Yves. *Nouveau Traité des Maladies des Yeux*, 1767, p. 174.

[213]Knapp. *Archiv für Ophthalmologie*, 1868, Vol. XIV., I., p. 273.

In 1873, de Wecker[214] incised the entire conjunctival limbus, dissected it backwards, and placed four differently tinted sutures in the conjunctival border in positions as shown in figure 470. He excised the staphylomatous area, and after liberating and expelling the crystalline lens, brought the wound together. In 1882, as Beard says, "he wisely concluded to make complete exenteration of the globe before closing the wound.[215]

Borghetti[216] has made use of the first and second steps in the modified de Wecker operation. He detaches the conjunctiva from the sclera for about the width of one centimeter around the corneal limbus. He places a circumferential purse-string suture in the detached portion of the conjunctiva. A second purse-string suture is made into the superficial layers of the sclera and episcleral tissue; this suture

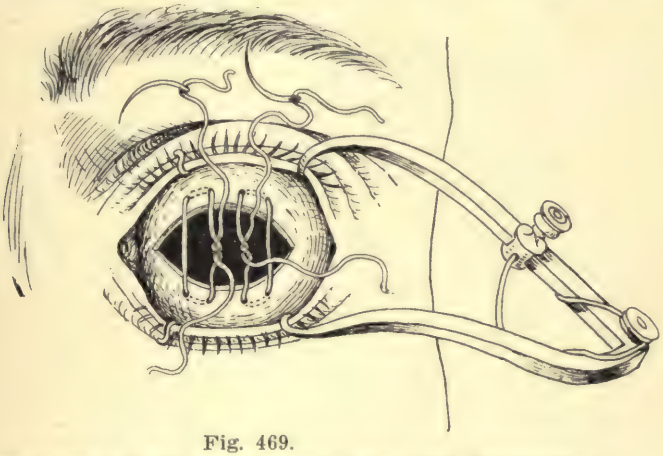


Fig. 469.
Position of Stitches in Knapp's Operation for Total Staphyloma.

is bound except at the lower part of the eyeball where the two ends are made to pierce the conjunctival membrane. By pulling upon the two ends of the thread, the eye is fixed and closed, while a flap which is equal in size to four-fifths of the tissue to be removed, is made by means of a cataract knife. The loosened flap, which is still adherent to the lower part of the eyeball, is now ready to be excised. The conjunctiva is brought in front of the eyeball. Lastly, the suture holding the sclerotic is loosened to prevent the ciliary nerves from suffering compression, and the two ends of the thread are knotted.

He claims that with this method of procedure, "The ciliary nerves

---

[214]de Wecker. *Annales d'Oculistique*, XIX., p. 51, and de Wecker and Landolt. *Traité complet d'Ophtalmologie*, 1886, tome II., p. 208.

[215]Beard. *Ophthalmic Surgery*, 1910, p. 39.

[216]Borghetti. *The Practical Medicine Series*, Vol. III. (The Eye, Ear, Nose and Throat), 1909, p. 56.

suffer no pressure and there is no fear of sympathetic ophthalmia:" 2. "The method can be applied where other methods cannot, and even, when chloroform is contra-indicated, or when intelligent assistance is not easily found," and 3, "An artificial eye can be placed on the stump which moves freely in all directions."

In cases of adherent leucoma with thinning of the cornea and the formation of staphyloma, Sachs[217] suggests the trephining of the central part of the cornea with von Hippel's trephine, release of the iris, and replacement of the disc. He believes that the success of the procedure is due to a permanent lowering of intraocular pressure, as a consequence of the release of synechia, and to a flattening of the cornea which results from the scar tissue.

The present operation of staphylectomy is done in the following

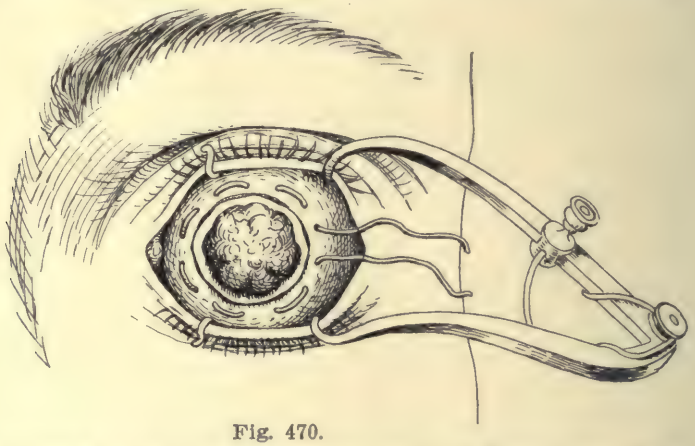


Fig. 470.
Position of Stitches in de Wecker's Operation for Total Staphyloma. First Stage.

way: After the usual preparation of asepsis and fixation, the staphylomatous mass is separated from its base for about two-thirds of its extent. This is best done by a Beer knife, as shown in the sketch.

The second step in the procedure, consists in removal of the remaining portion, or better, whenever possible, to conform it into a flap to cover the opening and "to serve as the formation of a flat cicatrix."

The best-known operation for removal of the cicatricial total type of staphyloma is that of George Critchett.[218] It consists in the removal of an elliptical portion of the cicatrix and an uniting of the edges of the wound by stitches. It is only suitable in cases of total cicatricial

[217]Sachs. Ueber die Lösung vorderer Synechien nach vorangeschickter Hornhauttrepanation. *Zeitschrift für Augenheilkunde*. January, 1902, p. 37.

[218]George Critchett. On Abscission in Staphyloma. ***Royal London Ophthalmic Hospital Reports***, Vol. IV., 1863, part I., page 1.

staphylomata, especially in those "with thick walls or even button-like thickened zenith, where a restitution of vision is impossible, and it is only a question of forming a stump for an artificial eye."

General anesthesia is necessary. After the parts have been prepared, and the eyelids separated by a stop speculum, four or five needles, armed with surgeons' silk, are passed through the staphylomatous area, and, at times, the sclera in the ciliary region, in the same manner as shown in the sketch. This done, an elliptical area, made in the points of entrance and exit of the needles, is excised by means of a Beer knife and a pair of scissors. (This is also well shown in figure 473.) The elliptical flap in the staphyloma removed, the free edges are brought together and tied with the silk sutures, which are allowed

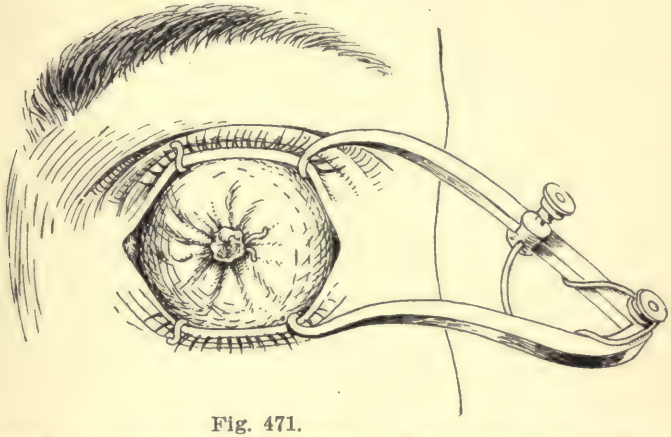


Fig. 471.

Position of Stitches in de Wecker's Operation for Total Staphyloma. Final Stage.

to remain *in situ* until the parts are well united; the period of time averaging about a fortnight. The author of the operation states that the crystalline lens must be removed at the time of the procedure.

Proeller[220] makes use of transplantation of the cornea simply to get rid of enucleation or of its substitutes in functionless eyes that are affected with total staphylomata of the cornea—particularly in those cases which have followed severe ulceration.

Iridectomy in Staphyloma Corneæ.

Sperino[221] reports some very interesting and instructive cases of the disease in which the value of iridectomy alone or in association

[219]Stellwag von Carion. *Treatise on the Diseases of the Eye* (American Edition), 1868, p. 107.

[220]Proeller. *Archiv für Ophthalmologie*, LVI., 2, S. 315.

[221]Sperino. *Etudes Cliniques sur l'Evacuation Repétés de l'Humeur Aqueuse dans les Maladies de l'Oeil* (French translation by Raymond), 1862, p. 343.

with repeated evacuation of the aqueous humor, are compared and contrasted; the combination of the two methods apparently giving the better results. Von Graefe[222], realizing the important fact that excision of a portion of the iris diminishes intraocular pressure, applied it to the treatment not only of conical cornea, but usefully to some staphylomata conditions. It is also of value, he says, in favorably changing the position of the pupil in such cases. It is probably of the most use in the progressive types of the disease.

In 1829, Flarer[223] resorted to the establishment of an artificial pupil after repeated punctions with a cataract knife had been employed.

Himly[224] has also made use of iridectomy in the operative treatment of partial staphyloma of the cornea.

Berry[225] gives an excellent chromolithograph of a case of partial

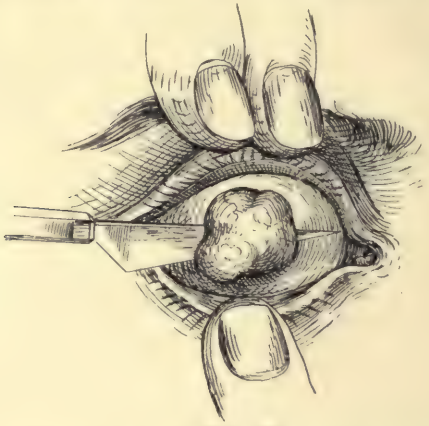


Fig. 472.
Partial separation of staphyloma from its base (Stellwag).

central staphyloma of the cornea, for which iridectomy had been performed.

As all of the procedures for the total form of protrusion are not intended for restoration of sight, but are done simply to get rid of discomfort, and, not infrequently, pain—which are the usual accompaniments of the condition, and to improve appearance and to offer better prothesis, they are here mentioned more for historic reasons than for practical ones to follow.

The coarse radical procedures that were so rife during the nine-

[222]von Graefe. *Archiv für Ophthalmologie*, IV., II., S. 271.
[223]"Tentativi per attenere la guarigione dello stafiloma parziale della cornea e nuovo methodo di profilassi dello stafiloma totale." Milano, 1829, and Stoeber. *Manuel Practique d'Ophtalmologie ou Traité des Maladies des Yeux*, 1834, p. 272.
[224]Himly. *Krankheiten des Auges*, 1843, S. 69.
[225]Berry. *Diseases of the Eye*, 1889, p. 69.

teenth and earlier centuries were mostly employed for the removal of the complete or the total form. None of them, however, can be recommended, as both empircism and scientific study have showed that they not infrequently give rise to conditions which are of much more danger to subsequent binocular blindness, than if the parts had been left alone.

With Berry[226] in his assertion that "the most suitable operation for cases of complete staphyloma is evisceration of the globe," the writer is in accord.

Excision of Prolapse of the Iris.

Iris prolapse may take place both during and after the operation for simple extraction. It is of not infrequent occurrence in other ocu-

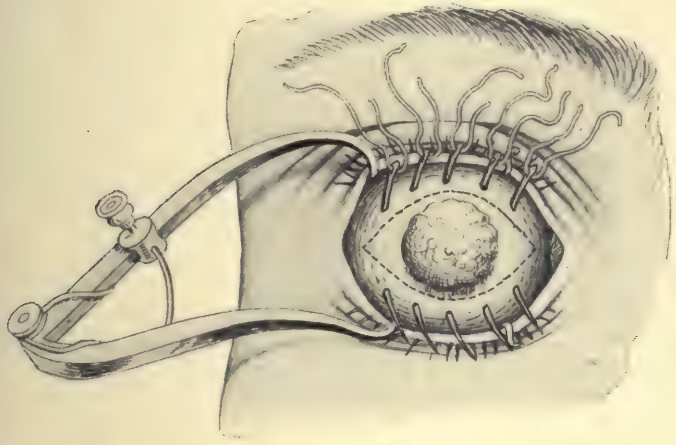


Fig. 473.

Implantation of Needles and Excision in Critchett's Operation for Total Cicatricial Staphyloma.

lar traumatism in which the anterior segment of the eyeball is injured. It may be also seen in cases of perforating ulcer of the cornea.

Wenzel,[227] in speaking of protrusion of the iris and of the lenticular capsule following the operation for the removal of cataract, states that while it "is an accident, much less likely to happen after our mode of operating, than after any other," he leaves such cases "to nature, whose operations are always salubrious, and fully competent to the cure of this disease."[228]

---

[226]Berry. *Diseases of the Eye*, 1889, p. 613.

[227]Ware. Observations on the Cataract and Gutta Serena; Including a Translation of Wenzel's *Treatise on the Cataract*. etc., 1812, p. 216.

[228]Loco citato, p. 223.

In 1820 Carron du Villards[229] proposed a combination of excision and cauterization for the treatment of all forms of secondary hernias of the iris.

In the treatment of a small *procidentia iridis* from corneal ulcer, Travers[230] touches the prolapsed portion of the iris with a caustic pencil ground to a fine point. If the prolapse be large and extending, he snips it off with a pair of curved scissors, followed by the use of the caustic. By this plan, he has "seen many cases recover with good, though abridged vision.

Mackenzie[231] snips the prolapsed portion of the membrane off with a scissors—after attempts to reduce it have failed. White Cooper[232] makes use of the same practice in fresh wounds.

Wharton Jones[233] tells us very emphatically that "when, in con-

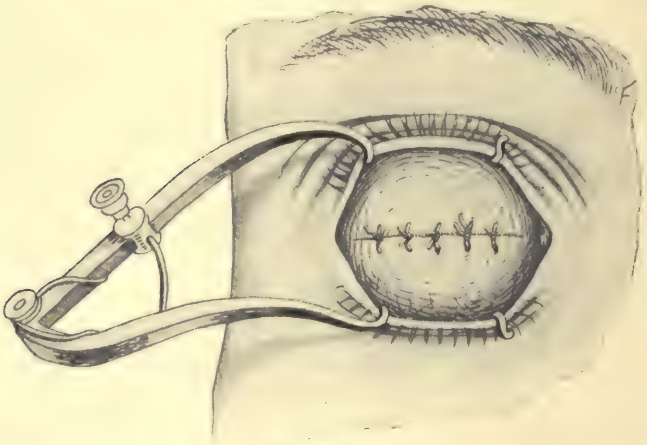


Fig. 474.

Arrangement and Position of Interrupted Sutures in Critchett's Operation for Total Cicatricial Staphyloma.

sequence of penetrating ulcer of the cornea, prolapse of the iris has taken place, there should in general be no direct interference with the prolapsed iris. The attention ought rather to be directed to the removal of the inflammation, of which the prolapse of the iris is the remote consequence, in order to promote the result above described." Most certainly, bad advice if taken in its accepted meaning.

---

[229]Carron du Villards. *Guide Pratique pour l'étude et le traitément des Maladies des Yeux*, 1838, tome 2nd, p. 202.

[230]Travers. *Synopsis of the Diseases of the Eye, and their Treatment*, American Edition, 1825, p. 304.

[231]Mackenzie. *A Practical Treatise on Diseases of the Eye*, 1833, American Edition, p. 253.

[232]White Cooper. *On Wounds and Injuries of the Eye*, 1859, pp. 113-114.

[233]Wharton Jones. *The Principles and Practice of Ophthalmic Medicine and Surgery* (American Edition by Isaac Hays), 1847, p. 186.

Baudry,[234] in speaking of traumatic lesions of the cornea, pertinently says, that if there is a marked hernia of the iris, he practises its resection with the pince-ciseaux; but if it is small and fresh, he attempts reduction.

It stands as an ophthalmic dictum that every fresh prolapse of the iris should be immediately excised.[235] It is useless to replace them. The procedure immediately removes a bruised and not infrequently, infected area, which, at the best, if left alone, can but heal with an irregular and sight-disturbing scar. The operation when carefully, judiciously and neatly done, gets rid of the implicated portion of iris tissue and produces a cleanly cut and, in consequence a rapidly healing edge, which, when properly made, will be frequently continuous with the undisturbed portion of the pupillary border. Iris prolapses that are replaced, are very apt to recur.

For the best results after performance of the procedure, the parts should be thoroughly cleansed, several drops of a fresh, unboiled neutral solution of hydrochlorate of cocaine instilled into the conjunctival sac, and a Murdoch speculum gently introduced into position. In some cases, particularly in young subjects and among the nervous and excitable class of patients, it is advisable for best and adequate results, to resort to general anesthesia before the operation is attempted. After the eyeball has been fixed with a pair of fixation forceps, preferably rubber-tipped, stronger solutions of cocaine may be employed at the time of the further extrusion of the iris tissue. The writer has never found it necessary to make use of adrenalin. The protruding portion of the membrane with the incarcerated portions are drawn strongly and as far as possible, forward, without injury to the parts, and in such a manner as to entirely free the caught portion of the membrane from the lips of the wound. The protruded mass is then gently and neatly excised. All ragged points, with the underlying bruised area, must be removed. If this be done, in fresh cases, and all of the offending tissues be cleanly excised, the best of results both as to vision and as to the integrity of the eyeball, will be obtained.

Dr. Frank Fisher (one of the writer's colleagues at the Wills' Hospital), and the writer, have successfully made this their rule of procedure in fresh cases—for many years—in all of their private and public work.

If the prolapsed portion of the iris be covered with a fibrinous exudate the exudation must be removed with a pair of forceps, permitting the prolapse of the iris to be fairly seen. The extruded bead of iris must be gently and fully freed from all of its corneal attach-

[234] Baudry. *Thérapeutique oculaire usuelle*, 1901, p. 106.

[235] *Vide* p. 209, *Ophthalmic Surgery*, by Josef Meller (English Translation reviewed by Walter L. Pyle, Phila.), 1908.

ments by a spatula without interference with the underlying lens capsule. During this procedure the aqueous humor will constantly come out, bringing the anterior capsule of the lens and the underlying tissue against the posterior surface of the cornea. The freed and prolapsed portion of the iris is seized with an iris forceps in such a way as to include all of those portions that are necessary to remove, within its grasp. The included portion is drawn out, gently freed from its corneal attachments, and excised with a de Wecker's or a McClure's scissors. Before the excision, the instrument must be firmly pressed against the corneal membrane—thus offering better opportunity for removing some of the underlying iris tissue that is situated in the anterior chamber, and giving a clear-cut artificial pupil; this being assisted by the natural retraction-process of the iris tissue, which springs into position the moment that any traction efforts of the iris forceps cease.

If the cut edges of the iris do not seem to be in a good situation, or desired-for position, they may be reset by the careful use of a spatula introduced through the corneal wound. If the wound does not seem to be quite large enough, or if its edges be too jagged, it may be judiciously enlarged or resected by either the use of a Beer's knife introduced in such a way as to cut from within outwards, or a single snip of a delicate though strong pair of sharp scissors. Quite often, as a result, the iris will fall into better position, the coloboma will become broadened and bettered, and, not infrequently, the iris tissue will sink to its proper plane. If this be impossible, more of the iris tissue may be reached for with a pair of fine iris forceps or with an iris hook, gently extruded, and excised. The uninjured portion of the iris will, as a rule, then sink back into excellent position as a result of the manoeuvre. After the procedure has been completed, a few drops of a neutral solution of atropine should be instilled into the conjunctival sac and against the wound, in order to retract the remaining iris tissue away from the seat of traumatism; thus preventing, as far as possible, incarceration of the edges of the tissues of the iris in the corneal wound. An occlusive bandage kept saturated with iced compresses, with rest in bed, are all necessary for good result. The bandage must be gently removed, the eye dressed with boric acid solution, and atropine instilled once or twice daily until the wound is firmly and properly healed. This will, ordinarily, take place in from forty-eight to seventy-two hours' time, particularly in cases of small, uninfected perforation.

Although the age, the extent, the position, and the size of the prolapse have important bearings upon the prognosis, yet it is the duty of every ophthalmic surgeon to operate immediately and judiciously in every case in which improvement of conditions can be expected.

In old cases, the danger and the degree of intraocular infection are

greatly increased, while the wound is more apt to be slow in its process of healing. Should the lens capsule have been ruptured, or should it have become broken during or after the procedure, the extruded, and not infrequently, swollen, lens material, should be delivered through the wound by the aid of a carefully introduced and judiciously employed grooved spud. Capsular debris, unless easy of and unharmingly capable of removal at the time, should be left for excision to as early a time as may be properly possible.

In a few cases in which there is more extensive destruction of the parts, and in which the prolapse offers itself as a bulwark to the preservation of the eyeball, it is wise to leave it in position until later. Constant watch as to the increase of intraocular pressure should be kept, and, if found, radical procedures for the relief of the pressure symptoms must be made in ways that are best adapted to each individual case.

Harlan[236] is of the opinion that iris prolapse in simple extraction is not so serious as many operators believe. He advises that such protrusions, if they are small, had better be left untouched unless they interfere with the healing processes of the wound. He considers the best treatment for a large proportion of more extensive prolapses is prompt abscission; though infective inflammation of the iris or conjunctiva may necessitate delay. He further says, that in a certain number of instances there may be a third choice of treatment, besides abscission and expectancy, viz., *replacement*. This (he properly tells us), presupposes the absence of adhesive or septic inflammation.

In the discussion of Harlan's paper, Norris[237] believed "that large prolapses should be cut off, and that small ones are best treated by careful bandaging." Risley[238] was of the opinion that "a conjunctival flap rendered prolapse (in simple extraction), less probable by the more speedy healing of the wound which it promotes." De Schweinitz[239] stated that if the iris prolapse was noted soon after its recurrence, he would cut it off and reduce the edges of the iris; in other words, attempt to make a clean iridectomy. If the condition was not noted until the third or fourth day, and the prolapse had become incarcerated, he would treat the eye with a pressure bandage and atropin, believing that the latter agent did not increase the prolapse, and on the other hand, prevented iritis. He justly asserted "Necessarily, however, circumstances must alter methods, and each case must be studied by itself;" and Oliver (the present writer)[240] considered "the most important

[236]Harlan. Prolapse of the Iris after Simple Cataract Extraction. *The Ophthalmic Record*, February, 1900, p. 55.
[237]Ibidem, p. 94.
[238]Ibidem, p. 95.
[239]Ibidem, p. 96.
[240]Ibidem, p. 97.

factor in the question was the great danger of infection in cases in which with the prolapse there was an open wound." He offered the following as some of his individual conclusions in regard to the matter: "Post-operative prolapse of the iris in simple extraction is most apt to occur in cases in which the iris has been bruised during the procedure. It may be avoided by gentle massage of the iris through the cornea and the closed eyelids during the operation, but in all such cases, the conjunctival sac should be healthy, and freely flushed before the procedure. It should be replaced only in cases in which it is fresh, and in which the protruding iris tissue, the wound of incision, and the conjunctival membrane appear normal. It should be excised only in fresh cases in which the protruding iris tissue is bruised, and the conjunctival sac is practically free from secretion." (In this connection, it must be remembered that in ordinary traumatism, there is not such an aseptic field and that the inflicting instrument is, as a rule, unclean).

In speaking of prolapse of the iris in simple extraction, Parinaud[241] believes that iris prolapse is more common after this form of removal of cataract than in the combined operation.

Gruening[242], in speaking of the treatment of traumatic prolapse of the iris, wisely does not employ replacement as he is convinced (in which the present writer agrees), that "the prolapsed iris is no longer aseptic and may infect the interior of the eyeball." Abscission which leaves the iris tissue in the wound is not to be recommended "because the synechia is not disposed of." He believes that "excision is preeminently the correct method." He has practised this method many years, and often succeeded "in making a clean iridectomy by pulling the iris through the wound in such a manner that the perfect result of an iridectomy is obtained, with the pillars of the iris well placed in the anterior chamber." As before said, this is and has been the rule of Dr. Fisher and the present writer in ordinary traumatic cases for a long period of time.

Gruening [243] tells us "at times, however, the lens capsule or a tag of the iris still remained adherent to the corneal wound, and in such cases, after the re-establishment of the anterior chamber and firm union of the wound, the use of Knapp's needle-knife for the cutting of the adhesion has yielded very satisfactory results. In introducing the knife into the anterior chamber (he tells us), the shaft of the knife closes the wound, the anterior chamber is not emptied, and even in cases of broad adhesion, the iris or capsule of the lens may be readily severed."

---

[241]Parinaud. Le prolapsus de l'iris dans l'extraction simple de le cataract. *Bulletins et mémoires de la Société française d'Ophtalmologie*, 1891, p. 239.
[242]Gruening. Trans. *American Ophthalmological Society*, 1909, p. 104.
[243]Loco citato, p. 105.

Taylor[244] has described a procedure in which he prevented prolapse of the iris after cataract extraction by separating the iris from its peripheral attachment, instead of removing a segment of that membrane, without invading the pupil and then extracting the cataract in the usual way. He did this by pinching up a minute portion of the iris, and snipping it off as close to the periphery as possible. (See also Chandler's method).

Williams[245] has given a description of a method of introducing sutures into the cornea for the prevention of *procidentia iridis* following cataract extraction. He seizes "the point of the flap with an iridectomy forceps and then, passing the needle through the flap, through the superficial layers of the cornea, and then having placed the suture in the corneal flap" (he introduces), "the needle through the opposite edge of the wound and tie(s) it, using a very fine thread." It is, as the author says, "very desirable that complete anesthesia should be produced."

For a long time the present writer has successfully employed the well-known Kalt stitch for the same and similar purposes. He uses the finest strands of black iron-dyed silk. Terson[246] prefers the very fine tendons of the reindeer for his suturing material.

Tooke[247] believes that incarceration of the iris in an infected corneal wound not only acts as bulwark against the entrance of bacteria into the eyeball, but that the blood vessels of the iris assist in carrying off the localized infection. He also says that the process of actual healing or of granulation tissue formation is assisted by the presentation of the iris. He does not deem it wise to perform an iridectomy or to break any anterior synechia.

Gifford[248] speaks of the danger of "sympathetic ophthalmia" from the use of the cautery in the treatment of iris prolapse. His conclusions are as follows: "1. Fresh non-infected prolapses should be replaced, if possible, preferably by Dunn's method: 2. Prolapses which cannot be cleanly excised should, if possible, be cauterized and the area scraped and protected at once by a conjunctival flap: 3. On account of the danger of sympathetic ophthalmia no prolapse should be treated by a hot metal cautery, unless a protecting conjunctival flap can be made to adhere to the area cauterized; it is probably safer to let the prolapse

[244]Taylor. *Report of the Fourth International Ophthalmological Congress*, 1873, p. 33.

[245]Williams. *Report of the Fourth International Ophthalmological Congress*, 1873, p. 176.

[246]Terson. *Bulletins et mémoires de la Société française d'Ophtalmologie*, 1908, p. 107.

[247]Tooke. *The Ophthalmic Record*.

[248]Gifford. *The Journal of the American Medical Association*, 7th May, 1910, p. 1531 (and presessional volume of the Section on Ophthalmology of the American Medical Association, 1910, p. 197).

alone: (and) 4. In some cases of large corneal prolapses to which conjunctival flaps can be made to adhere with difficulty or not at all, the use of trichloracetic acid (and probably of various other chemicals) produces a firm, non-irritable scar. Whether this method is entirely devoid of danger remains to be seen."

Conjunctivoplasty.

In 1876, Schöler[249] recommended transplantation of pedunculated conjunctival flaps in the radical treatment of corneal ulcers and wounds with and without iris prolapse, beginning staphylomata, etc.: Kuhnt[250] has advised this mode of treatment particularly in large prolapses of the iris and gaping wounds of the cornea. Both of these authorities state that the procedure is beneficial for the removal of local pain. De Wecker[251] has made use of the method for the closing and the protection of large corneal wounds. It is of value by closing the defect with solid tissue after the excision of the prolapse, and protecting the eye from extensive synechia: Weiss[252] speaks of its usefulness in this connection. It is said to be of value in perforated ulcers and loss of corneal substance from other causes, though Knapp[253] wisely states "An aseptic corneal ulcer, I think, needs no conjunctival flap to cover it, and whether it is prudent to cover an infected ulcer, however carefully sterilized, has, to my mind, to be proved by further clinical observation:" Weiss[254] on the contrary, asserts that such misgivings have proved unfounded. Meyer[255] and Herman Snellen[256] have written upon its advantages. Byers[257] employes them usefully to cover the entire corneal section in cataract extraction which is complicated by lachrymal diseases.

Ball[258] says that penetrating wounds of the cornea should be covered with a conjunctival flap in order to prevent secondary infection. He tells us that "If the wound is situated at the periphery of the cornea, the simplest method of covering it will be to loosen the con-

---

[249]Schöler. Ueber Heilung von Hornhautwunden und Geschwüren mittel Deckung durch Bindehautlappen, 1876, 1878, Krebs, Doctor. Dissertation, Berlin, 1878. *Berliner Klinische Wochenschrift*, 1884, S. 421, and *Bericht über der Ophthalmologischen, Gesellschaft*, Heidelberg, 1885, S. 225.

[250]Kuhnt. Vorschlag einer neuen Therapie bei gewissen Formen von Hornhaut-Geschwüren, Wiesbaden, 1884.

[251]de Wecker. *Annales d'Oculistique*, 1894, CXII., p. 293.

[252]Weiss. *Archiv für Augenheilkunde*, 1896, XXXIII., S. 311.

[253]Knapp. *System of Diseases of the Eye*, Norris and Oliver, Vol. III., 1898, p. 833.

[254]Weiss. *Archiv für Augenheilkunde*, Bd. XXXIII., S. 314.

[255]Meyer. Bericht über der 22 *Versammlung der Ophthalmologischen Gesellschaft, Heidelberg*, 1892, S. 192.

[256]Snellen. Report of the VIII. *International Ophthalmological Congress*, Edinburgh, 1894.

[257]Byers. *Transactions of the American Ophthalmological Society*, 1910

[258]Ball. *Modern Ophthalmology*, 1904, p. 353.

junctiva all around the cornea, and insert a purse-string suture. This is to be tied and is left *in situ* for several days. If the wound involves the center of the cornea, a loosening of the conjunctiva with the excision of a suitable area of this membrane, will be required. In simple, clean-cut corneal wounds, this method of treatment may not be necessary. In lacerated wounds it should be adopted."

Snell[259] has resorted to the method.

It has been successfully employed in cases of transplantation of the cornea where it is desired to retain the transplanted area in its desired-for position, before it becomes fixed. In such cases, the conjunctival flap may be either excised or turned back into its original place.

A patient of Critchett's[260] upon whom abscission of anterior staphyloma had been performed and in which "the conjunctiva was drawn together by five sutures over the aperture of the globe," presented a "softish, good-sized stump," upon which an artificial eye had been placed.

Fig. 475.
Kuhnt's Method of Making Tongue-like Conjunctival Flap.

The procedure consists in excision of the prolapsed portion of the iris in such a way as to leave, for example, the thinned and ulcerous area of the cornea directly opposite the coloboma and "free from any" synechial attachment. All overlying epithelium in the flat variety is to be curetted free. If the epithelium is more abruptly and perpendicularly placed, union of the parts may be facilitated by judiciously scraping the thickened massings as thin and as flat as may be thought best in each individual instance.

Local analgesia is all that is necessary for the procedure.

A broad, tongue-like flap is dissected from the bulbar conjunctiva which is nearest to the colobomatous area, with a pair of scissors, in such a way that the edge of the flap approximating the cornea is parallel with the limbus. This is well shown in figure 475. The width of the flap should be made about twice the width of the ulcer.

---

[259] Snell. *The Ophthalmic Review*, 1887.

[260] Critchett. *Ophthalmic Hospital Reports and Journal of the Royal London Ophthalmic Hospital*, Vol. II., 1859-1860, p. 115.

The flap is freely dissected free, and the still-attached base is carried sufficiently far back, broadened and shaped so that it may be easily turned into position over the ulcerous area without any degree of strain or of tension upon the flap.

In centrally placed ulcers, the flap is best made from both above and below in such a way as to cover the affected corneal area in a vertical manner as shown in figure 476, there usually being a greater abundance of conjunctival tissue in these situations: There is also less traction from the exterior muscles of the eyeball. Both Weeks[260a] and Oliver[261] have made use of the method.

A third plan employed by Kuhnt in order to cover a corneal wound, is well shown in figure 477.

Care should be taken not to excise too much conjunctival membrane, as the movements of the eyeball may be interfered with.

Arranging the flap in proper position, its apex (of the tongue-like variety) is fastened to the bulbar conjunctiva on the opposite side of

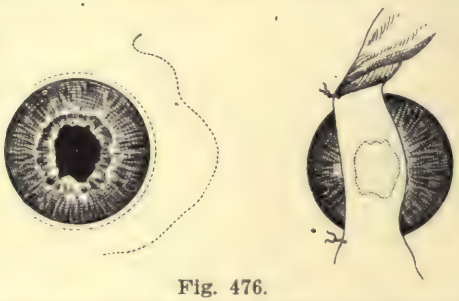


Fig. 476.
Kuhnt's Method of Making Centrally Placed Conjunctival Flap.

the cornea, so as to cover the ulcer. The apex of the flap is sutured into position by several fine stitches, taking care that the curved ends of its apex do not curl out of place. (See figure). The other two types are similarly stitched into proper positions. If there be an undue tendency of the flaps to curl upon their sides, they may be held down by a couple of laterally-placed sutures, taking care never to encroach upon the corneal membrane.

As a rule the sutures are apt to cut out in twenty-four to forty-eight hours; but not infrequently the flaps will have laid themselves into correct position by that time.

The denuded area in the conjunctiva from which the flap has been taken may be either left to heal of itself; or, if there is any undue tension, a series of fine incisions in the still-attached portions of the membrane may be made. These cuts are best put into those positions

[260a] Weeks. *Transactions of The American Ophthalmological Society*, 1910.
[261] Oliver. *Transactions of The American Ophthalmological Society*, 1910

which may be deemed most advisable in each individual case. Some surgeons prefer to draw the exposed area together with a number of fine, loosely-placed sutures.

After the procedure, both eyes should be so bandaged that all ocular movements are prevented, thus insuring better position of the flap. Care should be taken during the application of the bandage—particularly the first one—to see that the flap is evenly placed and that it is not curled nor twisted. If there is any such tendency, the flap should be carefully reset, by any plan of cutting and suturing, that may seem best under the circumstances. The bandage should be changed daily, and the field of operation should be gently cleansed and kept free from all contamination and injurious secretion. The double bandage should not be changed to a single one for at least seventy-two hours after the operation. The flap is quite apt to become swollen during the first few days, gradually flattening and smoothing down to a normal condition. It should not be separated from its attach-

Fig. 477.

Kuhnt's Third Method of Making Conjunctival Flap to cover Corneal Wound

ments until the parts are free from all inflammatory reaction; or, better, when the healing process has fully taken place. The amount of separation which is readily accomplished with the aid of a pair of sharp, curved-on-the-flat scissors, must be regulated in each individual case. Figure 479 exhibits the shape and situation of such a flap placed before an iridectomized area.

Kuhnt[262] has resorted to the employment of placing of non-pedicled conjunctival flaps over the situation of carefully cleansed ulcers of the cornea, with happy results both as to the healing of the ulcerous area and the prevention of iris prolapse.

In prolapse of the iris da Gama Pinto[263] excises the protruding portion of the membrane, and with a blunt probe presses a non-

---

[262]Kuhnt. *Bericht der Ophthalmologischen Gesellschaft*, Heidelberg, 1885, S. 219.

[263]da Gama Pinto. Zur Behandlung des Irisvorfalls bei Hornhautgeschwüren. *Klinische Monatsblätter für Augenheilkunde*, 1887, Bd. XXV. (January), S. 1.

pedunculated piece of conjunctiva into the corneal wound so that the two raw surfaces become approximated. Valude[264] recommends da Gama Pinto's method of procedure. He first disengages the iris tissue from the lips of the corneal wound. Stellwag von Carion[265] has given a thorough review of the subject. He thinks that large flaps should be employed by reason of the free motility of the eyeball. He says that one of the great hindrances to success is the desquamation of the epithelial covering and the development of granulations.

In wounds of the sclero-corneal region, Nuel[266] speaks well of the plan of making a procedure which carries a conjunctival flap over the ruptured area. The accompanying sketch shows the lines of insertion of the suture.

Tattooing of the Cornea.

Tattooing of the cornea is a useful procedure for the improvement of the appearance of the eye in cases of corneal leucomata. It is also valuable where there are superficial opacities of the cornea that are situated in the pupillary area, doing away with visual disturbances that

Fig. 478.
Arrangement of Sutures in Conjunctival Flap.

are produced by dispersion of light while passing through the translucent area. Grandclément[267] speaks highly of the method as a curative measure in conical cornea. (Gayet[268] thinks that the happy result obtained in Grandclément's case was due rather to the scarification practised than to the tattooing. Nagoya[269] has proved by experiment and by quite a number of cases, that improved optical and visual results can be obtained by the tattooing of translucent corneal areas with India ink. It has been found useful in albinism, aniridia, and coloboma of the iris. At times, the material has been placed in the transparent cornea in order to lessen any undue dispersion of light which has been produced

[264] Valude. *Revue générale d'Ophtalmologie*, May, 1890.
[265] Stellwag von Carion. *Allegemeine Wiener medizinische Zeitung*, 1890, NRS. 27-29.
[266] Nuel. Des Ruptures sclero-corneennes, principalement au point de vue de leur Traitément. *Annales d'Oculistique*, XCIX., 1888, p. 264.
[267] Grandclément. *Lyon médical*, 2nd March, 1891.
[268] Gayet. *Lyon médical*, 2nd March, 1891.
[269] Nagova. *Beiträge zur Augenheilkunde*, 1905, Heft 64, S. 232.

by too extensive an iridectomy. In all of these latter cases, the area opposite the pupillary space should not be disturbed.

The operation, for cosmetic purposes, goes as far back as the time of Galen, who attempted to conceal such capacities by the use of ferric tannate and mixtures of powdered pomegranate bark and a salt of copper.[270] In 1868, Anagnostakis,[271] speaks of the plan as having been performed by the Greeks. Hirschberg[272] gives an interesting historical account of the procedure.

In 1870, the method was brought into vogue, particularly by Abadie and de Wecker[273]: de Wecker made his first attempt in his clinic in 1869.[274] Reuss[275] also speaks of the plan. Two years later, an excellent paper upon the subject was contributed by Ravà.[276] The same year Dunnage[277] and Ticehurst[278] gave good accounts of the method. Levis[279] and Woinow[280] made mention of the use of the colors; the latter of cinnabar and Berlin blue: while Taylor[281] employed sepia, ultramarine, and other tinting material to advantage, using a

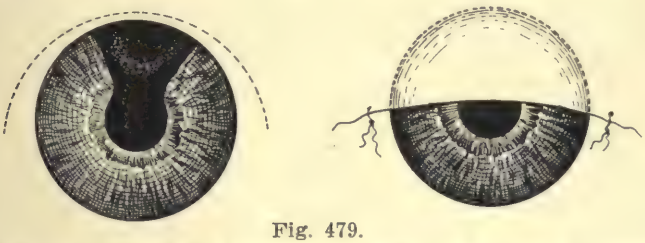


Fig. 479.

Shape and Position of Conjunctival Flap in Front of Coloboma.

combination of lampblack with India ink, and a solution of nitrate of silver where an immediate and deeply-colored effect was desired. The

---

[270]Panas. *Traité des Maladies des Yeux*, 1894, Tome I., p. 274.

[271]Anagostakis. *Annales d'Oculistique*, LXVIII., p. 126.

[272]Hirschberg. *Deutsche medicinische Wochenschrift*, 1891, Nr. XXX.

[273]de Wecker. Tatouage de la cornée, *Union médicate*, 1870, Mars. (In 1875, de Wecker and Ponti gave a combined explanatory paper upon the subject, Due Lettere rettificative sul tatuaggio della Cornea. *Annali di Ottalmologia*, p. 169.

[274]de Wecker. *Ocular Therapeutics* (English Translation by Forbes), 1879, p. 147.

[275]Reuss. Ueber Tätowirung der Kornea. *Wiener medizinische Presse*, 1871, S. 945.

[276]Ravà. Del tatuaggio della cornea. Sassari, Tip. Azuni, 1872, p. 32.

[277]Dunnage. On Tinting (Tattooing) opacities in the Cornea, *The Medical Times and Gazette*, 1872, I., p. 619.

[278]Ticehurst. Tattooing or Tinting opacities of the Cornea and Sclerotic. *The Lancet*, 1872, I., p. 619.

[279]Levis. The New Operation for Coloring Corneal Opacities. *The Philadelphia Medical Times*, 1872, 5th October, page 4.

[280]Woinow. Ueber Tätowirung der Kornea, Sitzungberichte der Gesselschaft russischer Aerzete Moscow, 1872, Nr. 13.

[281]Taylor. *The British Medical Journal*, 1872, 7th September, p. 271, and (The American *Journal of the Medical Sciences*, 1872, October, p. 561).

following year, Ponti[282] and Osio[283] wrote upon the same subject: In 1874, Klein[284] gave us a brief article upon the same, while Hirschberg[285] speaks of the plan. In 1903, Cofler[286] made use of blue, brown, red and yellow. The following year, Holth[287] wrote an extensive and important article upon the same subject. Two or three years later Chevallereau and Polack contributed a valuable paper on tattooing of the cornea in colors[288]. They made use of brown and red ochre, carbonate of copper, ivory black, Naples yellow, natural and burnt umber, and ultramarine blue. These materials, they say are obtained chemically pure, and are reduced to a fine powder. They are made into a properly-colored mass by being mixed with distilled water, and sterilized by being exposed to a temperature of 150 C. Insoluble-in-water pigments which can be

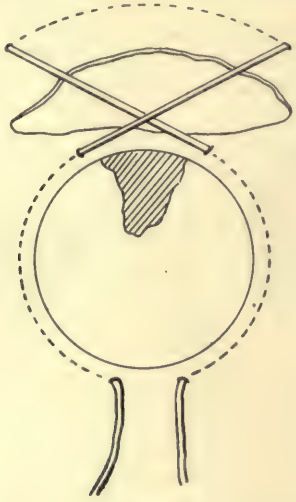


Fig. 480.
Conjunctival Flap Over Corneoscleral Break.

obtained in boxed sets at the present time are only those that should be used. They do not give rise to any reaction; though the sittings are

[282]Ponti Due lettere Rettificative sul Tatuaggio della Cornea. *Annali di Ottalmologia*, 1873, II., p. 507, Vol. 3, p. 169.

[283]Osio. Tatouage de la cornée. Cronica Oftalmologia, 1873. (See also the Use of the Salts of Lead in Eye Washes. Tattooing for Opacities of the Cornea, Mathewson, *New York Medical Record*, 1874, p. 589.

[284]Klein. *Weiner medizinische Presse*, 1874.

[285]Hirschberg. Eine kosmetische Operation. *Centralblatt für praktische Augenheilkunde*, Marz, 1887, S. 69.

[286]Cofler. *Annali di Ottalmologia*, 1903, XXXI., p. 169.

[287]Holth. *Annales d'Oculistique*, CXXXX., and Norsk Magazin fur Laegevidenskaben, 1904, p. 557. (See also Zur Technik der polychromen Hornhauttatowierung. *Periodischer internationales Ophthalmologen-Congress*, X. Luzerne.

[288]Chevallereau and Polack. Du tatouage Colorè de la cornée. *Annales d'Oculistique*, 1906, July, p. 26.

both numerous and tedious. Baudry[289] says that white is obtained from the salts of zinc or lead, blue from indigo and maroon from burnt sienna.

In 1873, Henry W. Williams[290], wrote a brief account of the plan, and Thomson[291] described an instrument for the performance of the method. The same year Hasner[292] speaks of the different pigment colors. This communication was rapidly followed by similar articles by Archer[293] and Hoch[294], and much later by Vacher[295].

Alt[296], Browicz[297] and Hirschberg[298] have determined that the introduced pigment aggregates in the interfibrillar lymph spaces, cells, and deep portions of the epithelial layers, and in the anterior part of the corneal stroma. Pigmented thrombi can also be seen. Parsons[299] confirms Hirschberg's findings. In 1894, Bajardi made an anatomic study of the infiltrated tissue[300], and gives an excellent illustration of the permeations. As early as 1876, Poncet[301], gave us a careful histologic examination of the corneal tissues, which had been infiltrated with the coloring material. Lippay[302], while describing his method of staining the cornea, gives a brief account of the microscopic findings in a case of experimental tattooing.

Goldberg[303], in a most careful examination of such a case, found that the artificial pigment was "infiltrated in the walls of the interlamellæ and canalicular spaces of the substance proper, leaving, in most cases, a hollow center." He states that the "corneal cells were in an unusually healthy state of preservation, and it was especially remarkable that but little proliferation of the connective tissues and infiltration had taken place in spite of the amount of traumatism one might expect

---

[289]Baudry. *Technique Operatoire Oculaire*, 1902, p. 628.
[290]Williams. *Boston Medical and Surgical Journal*, 1873, IV.
[291]Thomson. *Transactions of the American Ophthalmological Society*, 1873, p. 36.

[292]Hasner. *Beiträge zür Physiologie und Pathologie des Auges*, 1873.
[293]Archer. Versuche über Tatowirung der Hornhaut. *Archiv für Ophthalmologie*, XX., I. S. 225.
[294]Hoch. *Archiv für Ophthalmologie und Otologie*, 1876, I., S. 90.
[295]Vacher. Du tatouage multicolore de la cornée. *Bulletins et mémoires de la Société française d'Ophtalmologie*, 1887, p. 248.
[296]Alt. On the Microscopical Changes Found in a Tattooed Cornea. *The American Journal of Ophthalmology*, January, 1884, p. 8.
[297]Browicz. Ein Fall tatowirter menschlicher Hornhaut. *Archiv für Ophthalmologie*, XXIII., 1877, S. 212.
[298]Hirschberg. Anatomische und praktische Bemerkungen zur Alterstaarausziehung, Pupillenbildung und Hornhautfärbung. *Archiv für Ophthalmologie*, 1882, XXVIII., 1, S. 269.
[299]Parsons. *The Pathology of the Eye*, 1904, Vol. I., p. 253.
[300]Bajardi. Sul Tatuaggio della cornea. Torino.
[301]Poncet. Examen histologique des cornées tatouées à l'encre de Chine. *Gazette des hopitaux*, 1876.
[302]Schulek. *Ungarische Beiträge zur Augenheilkunde*, 1895, Bd. I., S. 79.
[303]Goldberg. *Pennsylvania Medical Journal*, 1910, June, p. 737.

to find accompanying the operation of tattooing. It was also noted that the line of the epithelium had not been disturbed and that but few pathologic changes had taken place in the cells."

The operation is most suitable in old leucomas and solid flat scars of unirritable eyes. The procedure should be avoided in thinned and ectasic scar tissues; in fact, the pigment will not remain in such cases. The method cannot be done safely when any iris tissue is included in the scar.

Study of individual cases will determine to what degree and to what extent, they should be subjected; the rule being that the less an eye is diseased, the more favorable will be the result and the less dangerous will be the procedure to the integrity of the eyeball.

Sterilized Indian inks of variously desired colors (preferably black, as it is much more certain to be permanent), carefully tested on rabbits' eyes for their harmlessness, are the pigmentation materials that

Fig. 481.
Coloration Massings in Old Pigmented Cornea.[304]

can be most successfully employed. In 1896, Hamilton[305] described a capsule bacillus which she found in the Chinese inks. It is fairly well shown in the accompanying lithograph taken from an article on the subject by Sicherer[306]. Mischina[307] has shown that all forms of ink are practically sterile and that contamination takes place while they are being prepared for use.

Small amounts of each are rubbed to oily consistencies either with plain boiled water or with solutions of gum arabic, and placed in covered sterile saucers. de Wecker[308] prefers to have the pigment material rubbed up in one to two-thousand strength solutions of bi-

[304]Terrien. *Chirurgie de l'oeil*, 1902.
[305]Hamilton. *Centralblatt für Bakteriologie und Parasitenkunde*, II, Abth., IV., Bande, Nr. 6.
[306]Sicherer. Untersuchungen über die Sterilisation der chinesischen Tusche zur Tätowirung der Hornhaut. *Archiv für Augenheilkunde*, XXXIX., Bande, Heft, I., S. 22.
[307]Mischina. India ink (In Tattooing of the Cornea). ***Annals of Ophthalmology***, April, 1903, p. 368.
[308]de Wecker. Le tatouage cornéen optique. ***Annales d'Oculistique***, 1897, p. 88.

chloride of mercury. He keeps the mass in a hot air sterilizer pending its use. The conjunctiva is then cleansed with freshly boiled water. A small piece of the pigment material is laid over the spot to be operated upon by the aid of a flat spatula. If other coloration tints (generally obtainable in the form of fine powder) are used, they should be washed consecutively in water, alcohol, and ether, followed by evaporation in a sand bath, sterilized and mixed with an aseptic solution of gum arabic.

Formerly, a single grooved needle, that of de Wecker, kept saturated with the pigment, was repeatedly introduced obliquely into the membrane until a satisfactory result was obtained. Some surgeons remove the epithelium which overlies the corneal area that has been chosen for the pigment deposition, thus rendering the placing of the coloration material into the corneal lamellæ easier; while others have the patient's eyes kept widely opened by a stop speculum after the

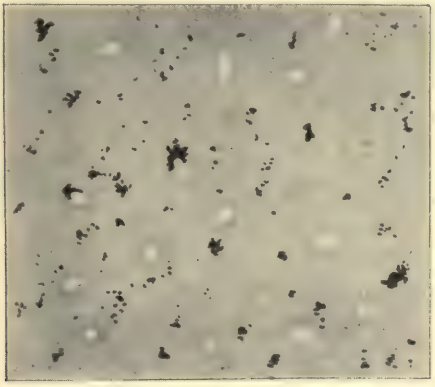


Fig. 482.
Capsule Bacillus Found in Chinese Ink.

procedure, in order that the pigment may not be so readily washed away. The operation has to be done several times at weekly intervals. It is a good plan, as suggested by Fox[309], to have the parts vigorously fanned during the proceeding, in order to produce rapid drying of the ink. Undue lachrymation may be avoided by frequent drying of the conjunctival sac with clean cotton gauze.

The present method is to use a pencil made of from four to eight round needles (Taylor's)[310], though the outline of the staining can be better obtained with the broad single needle. The writer employs both plans to advantage.

The parts are rendered as clean as possible. The instrument is

---

[309]Fox. *A Practical Treatise on Ophthalmology*, 1910, p. 223.
[310]Taylor. On the Modern Art of Tinting Opacities of the Cornea. *British Medical Journal*, 1872, 7th, September, p. 271.

sterilized. Thorough cocainization is absolutely necessary. The eyeball is steadied with a pair of fixation forceps, the prongs of which are covered with hard rubber or tortoise shell to prevent tearing, which would permit the pigment to stain the sclerotic. As de Wecker tells us, it is not necessary to complicate the operation by employing a stop speculum to fix the lids apart, particularly when the procedure is being made for optical purposes. The finger of the unused hand of the operator, or of an assistant, is sufficient to separate and to hold the eyelids in position. The needles are repeatedly thrust through the corneal epithelium sufficiently often and deeply enough, to make a great number of minute canals for the reception of the ink, which is either driven in by the needles themselves or, which does not seem to be so good, freely rubbed in with a sterile spatula. The excess of the staining material is removed by free irrigation with a warmed sterilized solution of boric acid or chloride of sodium. The procedure is to be repeated until the desired-for effect has been obtained. If any of the pigment is carried into the anterior chamber, the parts must be thoroughly cleansed and the chamber must be immediately opened with a keratome and flushed free.

Fig. 483.
Tyson's Tattooing Needle..

Tyson's Method of Corneal Tattooing.

Instead of using a bundle of needles, Tyson[311] employs five needle points, the length of each being equal to one-half of the normal thickness of the cornea; thus reducing the liability of penetration into the anterior chamber, even in the thinnest cornea, to a minimum.

Originally, the needles were set in a curve, the radius of which equalled the radius of the cornea. With this setting, the author found that the end needles produced the best results, as by yielding of the cornea the center needle did not penetrate sufficiently to give satisfaction. He remedied this defect in instrumentation by having the needles set upon a straight edge. With this modification, the center needle penetrated first, followed by the end ones—thus producing more uniform penetration.

His plan of procedure is as follows: After sterilizing and analgizing the eye, a stick of Chinese-India ink is allowed to stand with one end immersed in boiling, sterile water until the submerged portion of the stick becomes softened to a pasty consistence. A small quantity of the softened mass is spread over the parts to be tattooed with a

[311]Tyson. *New York Medical Record*, 1894, 2nd June, p. 709.

spatula. The tattooing needles are then repeatedly used, until as much as possible, or as may be desired, is forced into the corneal lamellæ. The site of the operation is kept moderately dry during the procedure. It is also occasionally wiped with moistened, sterile, absorbent cotton, in order to remove any excess of overlying ink, and to expose the actual amount of pigmentation which has been obtained.

When the desired color-results have been gotten, all of the loose particles of pigment are removed from the corneal and conjunctival surfaces by flushing with a sterile solution of salt. A drop of pilocarpine is instilled into the conjunctival sac, a light compress bandage is applied, and the usual method of post-operative treatment is followed.

Unless the tattooing is done, for example, over an anterior synechia, very little, if any, reaction follows. In such cases, the patient will experience some pain, notwithstanding local analgesia; and an increase in intraocular tension, which can be controlled by miotics, is apt to follow.

In Tyson's early cases he used atropine after the procedure, until a case of secondary glaucoma, which was checked in twelve hours' time, developed. Since that time, he has employed pilocarpine with excellent results in every instance.

Tyson tells us that this method of procedure may require more sittings in order to obtain desired results; but, in his opinion, it is far less dangerous to the eye than the older method with the long needles; it being practically impossible to force any pigment into the anterior chamber with his instrument.

Froelich's Method.

The method of Froelich[312] is a most excellent one for imitating the appearance of a pupil, particularly in cases in which there are broad, dense, flat scars. An area, equivalent in position, shape and size to the opposite pupillary one, is excised from the superficial layers of the cicatrix by means of a corneal trephine of von Hippel. The exposed surface is carefully scarified with the needle or a delicate scarifier. The pigment material, prepared to proper consistency, is rubbed into the exposed meshes of the scar, thus producing a good imitation of a black pupil. The surrounding area is graded into any desired shade and tinting by one of the needle methods. (The writer prefers to make the operation in two procedures, allowing sufficient time to elapse between them in order to observe the effect of the first).

The after-treatment is the same as that which has been recommended for the previous forms of operation.

---

[312]Froelich. Zur Technik der Tätowirung. *Klinische Monatsblätter für Augenheilkunde*, 1897, August, S. 301.

Holth[313] employs a corneal trephine to outline the pupillary area. He pricks the entire surface to be pigmented before he inserts the ink, making use of both cocaine and adrenalin prior to the procedure. He calls[314] attention to the priority of his claims for precedence of his method over that of Armaignac.[315] He also tells us that Czermak[316] as early as 1896, recommended the corneal trepan of von Hippel.

Barck's Method.

In order to obtain the characteristic feature of a black central pupil, Barck[317] has devised a double trephine (*vide* figure 485), which makes both the limits of the pupillary space, and the inner border of the iris-ring. After the obtainance of these boundaries by tattooing the central spot and leaving the surrounding area untouched, the tint of the periphery of the membrane is made to imitate the iris as much as possible wherever desirable.

Borsch[318] makes a pigment mass which is somewhat thicker than ordinary black ink, with a solution of bichloride of mercury, one to five thousand per cent strength. Starting with a central prick he carefully depicts a pupillary area around it. This is followed by an imita-

Fig. 484.
Corneal Trephine of Holth.

tion of the iris and its striæ, the striations being made by a series of oblique needle thrusts which radiate from the pupil.

Armaignac[319] has constructed a shield guide which is shaped like a bottomless saucer that exactly equals the size of the intended pupillary area. It is laid in position and fixed by small retaining hooks. It is then filled with the pigment massing, which is brought into direct contact with the area which is intended to be pigmented. The tattooing is performed in the included space. The greatest disadvantage that the contrivance possesses is that the field of operation cannot be made visible without removing the instrument. He has devised a second guide for the corneal size.

---

[313]Holth. Forhandlinger i det Norske medicinske Selskab i Kristiania, 1898, p. 430.

[314]Holth. De la création d'une pupille ronde et reguliere, etc. *Annales d'Oculistique*, November, 1903.

[315]Armaignac. Nouveau procédé pour le tatouage de la cornée. *Annales d'Oculistique*, 1903, CXXIX., p. 388.

[316]Czermak. *Die Augenärtzliche Operationslehre*, 1896, S. 649.

[317]Ball. *Modern Ophthalmology*, 1904, p. 359.

[318]Borsch. Corneal Tattooing. *Philadelphia Medical Journal*, November, 1903.

[319]Armaignac. Nouveau Procédé pour Le Tatouage Régulier de la Cornée. *Recueil d'Ophtalmologie*, August, 1903, p. 463.

Nieden[320] has constructed an useful fountain-pen tattooing instrument.

Hesse[321] makes use of a trephine. He places the ink against the exposed area, and resets the trephined plate into position. He reports three successful cases.

Any slight reaction which is apt to take place, is, as a rule, readily removed by asepsis, cleansing, instillations of weak neutral solutions of sulphate of atropine, and non-use of the eye by the application of a light occlusive bandage.

The stain, even when most skillfully placed, may gradually diminish or may even disappear, during the course of years.

Coarse, chronic and incurable inflammatory reaction, which is said to have followed the procedure, has been probably the to-be-expected result in badly selected cases and from improper technique. Transferred ophthalmitis is a sequel which can be but deprecated as expressive of either ignorance, or carelessness in the question of choice of case. Weeks,[322] in speaking of the method, says that he "has never

Fig. 485.
Double Tattooing Trephine of Barck.

seen any bad results; the epithelium is soon restored and healing is satisfactory, as a rule."

As de Wecker[323] tells us, we must remember that as far as the method is concerned, "We are yet in the infancy of that art." He justly states, however, that to "accuse tattooing of having given rise, long after it had been performed, to certain untoward changes in eyes, already at the time much disorganized, is to interpret facts amiss."[322]

In 1891, Hirschberg[324] called attention to corneal staining in relation to pupil formation. The following year, Bajardi[325] wrote an important paper upon the general subject.

---

[320]Nieden. Bericht über die 29 *Versammlung der Ophthalmologischen Gesellschaft*, Heidelberg, 1901.

[321]Hesse. Ueber die Ursache der Drucksteigerung bei Partialstaphylom der Hornhaut. *Klinische Monatsblätter für Augenheilkunde*, December, 1907, p. 511.

[322]Weeks. *A Treatise on Diseases of the Eye*, 1910.

[323]de Wecker. *Bulletins et mémoires de la Société de Chirurgie de Paris*, Seance, 30th January, 1878.

[324]Hirschberg. *Deutsche Medicinische Wochenschrift*, 1889.

[325]Bajardi. Giornale della reale Academia di medicina di Torina, 1900 (Academia medico-chirurgica).

CHAPTER V.

OPERATIONS FOR CONICAL CORNEA.—KERATOPLASTY.

By WILLIS O. NANCE, M. D., Chicago

General Characteristics of Conical Cornea and Its Early Recognition—Pathology—Historical Review of Surgical Procedures for Its Relief and Cure—Optical Iridectomy—Iridodesis—Removal of the Apex of the Cone—Abscission of the Cone and Cauterization—Trephining the Cone—Excision of a Segment from the Base of the Cone—Multiple Punctures—Cauterization of the Apex—Some Non-Surgical Procedures for Its Relief—Indications for Surgical Interference—Descriptions of the Two Methods Most Commonly Employed—Transplantation of the Cornea—Keratoplasty—Corneal Considerations—Historical Review of Corneal Transplantation—Indications for Keratoplasty and the Essentials for Operative Success—Description of Von Hippel's Trephine—Von Hippel's Operation.

CONICAL CORNEA.

General Characteristics and Early Recognition of Conical Cornea.

Conical cornea is a disease in which the central part of the cornea loses its normal convexity and assumes the form of a cone. The change is unaccompanied by inflammatory manifestations and the corneal substance usually retains its normal transparency. In some cases, at or very near the apex a small opacity may be determined.

The *apex of the cone*, as a rule, is not central, but usually below the center, its position being influenced, according to Noyes,[1] by pressure of the border of the upper lid. Females are more susceptible to the disease, and both eyes are usually affected. The deformity is seldom recognized before the twelfth or fourteenth year of life. At times, the deformity assumes an extraordinary size. Noyes[2] reports having observed a conical cornea three-quarters of an inch long.

Well-marked cases of conical cornea, when viewed in profile, are easy of recognition. All cases, even where the conicity is difficult of

---

[1]Noyes: *Diseases of the Eye*, New York, 1890, p. 387.

[2]Noyes: Discussion of paper on Treatment of Keratoconus by Means of the Galvano-cautery and Iridectomy, by Robert D. Gibson, *Journal Am. Med. Assoc.*, Sept. 10, 1892, p. 314.

determination, present a peculiar sparkling, diamond-like brilliancy, likened by Pickford[3] to a "dew-drop, or a piece of solid crystal, embedded in the corneal center." When light is thrown upon the cornea by the ophthalmoscopic or retinoscopic mirror, the reflex is observed tc be smaller at the center, and a dark circular shadow may be observed between the limbus and the center.

The image of the fundus is distorted. The corneal deformity may be demonstrated by Placido's disc or the ophthalmometer of Javal. The excessive thinness of the corneal apex may be demonstrated by touching it with a probe.

Conical cornea is variously known as *keratoconus, hyperkeratosis, staphyloma pellucidum conicum* and *conical hydrophthalmia.* Wardrop[4] was the first to suggest the name *conical-formed cornea,* or *conical cornea.* Demours[5] observed the condition as early as 1747. It is described in the French edition of Scarpa's[6] *Treatise of the Principal Diseases of the Eyes,* published in 1802.

Fig. 486.
Conical Cornea.

Pathology of Conical Cornea.

The precise mode of production or development of the disease has not been definitely determined. That conical cornea is a congenital deformity, like high degrees of myopia and keratoglobus, differing from

[3]Pickford: On Conical Cornea. *The Dublin Jour. of Med. Science,* XXIV, 1843, p. 355.

[4]Wardrop: *Essays on the Morbid Anatomy of the Human Eye,* vol. 1, p. 117, Edinburgh, 1808.

[5]Demours: *Traité des Maladies des Yeux,* Vol. 1, p. 316, Paris, 1818.

[6]Léveillé and Scarpa. *Traité des Maladies des Yeux,* Vol. 11, p. 179. Paris, 1802.

the latter in that the internal ocular structures show no implication even during the period of progression, is the belief of Sattler.[7]

Swanzy[8] says the "change is due to gradual and slowly advancing atrophic process in the cornea at or near its center, in consequence of which the normal intraocular tension acts on it so as to distort it into conical form. It is due to congenital weakness at the center of the cornea or by a chronic degeneration of the membrane of Descemet."

Historical Review of Surgical Procedures for the Relief and Cure of Conical Cornea.

The early attempts to remedy the distressing symptoms of conical cornea by surgical intervention were directed towards the alteration of structure behind the cornea rather than to change the nature of the deformity itself. In 1817, Sir William Adams[9] advocated the "breaking up of the crystalline lens in order that the rays of light might fall upon the retina and not be brought by the increased refractive power of the cornea and lens to a point far short of the sentient apparatus of the organ of vision." This procedure undoubtedly consisted of the so-called "needling operation," and appears to be the first surgical procedure employed in conical cornea.

Demours,[10] about that time, declared that "lorsque je suis consulté pour cette lesion, je conseille de n'y rien faire de particulier," and his suggestion was the probably accepted dictum to the time that Sir William proposed his operation. Adams' procedure evidently had few supporters. In 1840, Tyrrell[11] proposed "*altering the position of the pupil* and removing it from beneath the center of the cornea, or that part which has its figure most changed, to near the margin where the least change has occurred; the error in the refraction is consequently much lessened, and vision becomes more perfect and the focus is lengthened." Shortly after the publication of Tyrrell's work, Middlemore[12] made the claim that it was he and not Mr. Tyrrell who first made the suggestion of "altering the position of the pupil" in conical cornea, and quotes the following extract from his book published nine years before:[13]

---

[7]Sattler. The Surgical Treatment of Keratoconus, *Am. Jour. of Ophthalm.*, September, 1898, p. 257.

[8]Swanzy and Werner: *Diseases of the Eye*, Ninth Edition, p. 261, London, 1907.

[9]Adams: On the Restoration of Vision when Injured or Destroyed in Consequence of the Cornea Having Assumed a Conical Form. *Jour. of Ecience and Art.* (American Edition.) Vol. 11, 1817, p. 402.

[10]Demours. *Traité des Maladies des Yeux*, Vol. 1, p. 316, Paris, 1818.

[11]Tyrrell: *Practical Work on Diseases of the Eye and Their Treatment*, p. 277, London, 1840.

[12]Middlemore: Remarks on Conical Cornea, *Lond. Med. Gaz.*, Vol. 1, N. S., 1842-4, p. 544.

[13]Middlemore: *A Treatise on Diseases of the Eye and Its Appendages*, Vol. 1, p. 538, London, 1835.

"Where the point of the central cornea has become opaque and vision is thereby rendered much more obscure than it would otherwise be, it has been proposed to make an artificial pupil near to the margin of the cornea which it is said will have two important advantages, namely, first, removing the pupil from the opaque part of the cornea; second, allowing the light to be transmitted through the least convex part of the membrane."

Tyrrell's or Middlemore's operation consisted in making an incision through the cornea at or near the limbus and allowing of prolapse of a portion of the iris. This procedure was later modified by the elder Critchett,[14] who amplified the operation by what he termed *iridodesis* (q. v.) or *iridesis*—ligature of the prolapsed portion of the iris. After the iris had prolapsed into the corneal wound, it was tied off with a single knot; the strangulated portion sloughed and the remainder was included in the corneal cicatrix.

Bowman[15] was prominent among those to adopt the operation of iridodesis. Having observed that the vision of patients with conical corneæ was often improved by the use of the stenopaic slit, he attempted permanently to supply such an opening by converting the pupil into a transverse slit by means of an iridodesis, done twice in each eye. The frequent, severe and dangerous attacks of iritis and cyclitis consequent upon the operation, however, caused the procedure to be abandoned.

In 1847, Dix,[16] of Boston, revived the operation of *puncturing the cornea* at its periphery, which had been performed as far back as 1811.[17] The punctures were made daily, or oftener, with a cataract needle about 1/16 of an inch broad, and a compress bandage was applied. By this method it was hoped to permanently reduce the conicity of the cornea. Dix reports several cases in which there was marked improvement in vision. In one patient 144 corneal punctures were made during a period of 18 months.

A. von Graefe[18] in 1886 proposed, as a marked advance in the surgery of conical cornea, *the removal of the epithelial layer of the apex of the cone and the application of caustic.* The epithelial coat was shaved off, without entering the anterior chamber; the fragment of a

---

[14]Critchett. Further Remarks on the Formation of Artificial Pupil by Iridesis, *Roy. Lond. Ophth. Hosp. Reports*, Vol. 11, 1859-60, p. 145.

[15]Bowman. On Conical Cornea and Its Treatment, *Roy. Lond. Ophth. Hosp. Reports*, Vol. II, 1859-60, p. 154.

[16]Dix. Conical Cornea Curable. *Boston Medical and Surgical Journal*, May 12, 1847, p. 289.

[17]Lyall. Essay on Staphyloma Pellucidum Conicum. *Edinburgh Med. and Surg. Jour.*, Jan. 11, 1811, p. 6.

[18]von Graefe. Zur Heilung des Keratoconus. *Archiv. f. Oph.*, Vol. XII, 1866.

stick of nitrate of silver was later applied, and finally the floor of the resulting ulcer was punctured. The object of the procedure was to bring about gradual flattening of the cornea by cicatricial contraction. Severe intraocular inflammatory manifestations frequently followed the procedure and necessitated its abandonment.

In 1869, Bowman devised a trephine by which he excised a disc of corneal tissue at or near the apex of the cone. The instrument, while ingeniously devised, did not prove of great practical value on account of the extreme thinness of the cornea, and in a considerable proportion of cases the degree of contraction resultant from its use was inadequate to relieve the deformity.

Bader[19] reported a number of cases in which he performed *excision of the apex of the cone*. An elliptical piece was removed from the most prominent part of the cone with a linear knife in such a manner that the edges of the opening in the cornea approximate and completely close the artificial cleft. The chief and most serious complica-

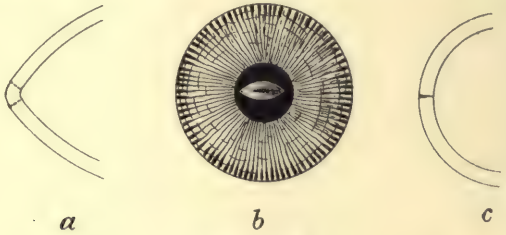


Fig. 487.

Critchett's Operation for Conical Cornea.

(*a* and *b*) Incisions Through Apex of Cone to Remove Elliptical Piece of Tissue, (*c*) Edges of Wound in Close Apposition.

tion of the operation was iris prolapse, with its attendant unfortunate sequelæ. To obviate this danger and to assist in early closure of the wound Badal[20] passed horse-hair sutures vertically through the cornea previous to removing the apex, and after abscission tied them over the opposed edges of the gap.

Critchett[21] removed a small elliptical piece of the cone at the apex, making the upper portion of the section with a very narrow Graefe knife, completing it with scissors; the fragments being removed with blunt forceps. Bader's operation, even with its modified technic, was more or less hazardous on account of the violent reaction, probability of

---

[19]Bader. Treatment of Conical Cornea by Removal of the Top of the Cone. *The Lancet*, 1872, p. 73.

[20]Badal. Trois Cas de Kératocone. Résultate immédiate ét eloignes des Interventions chirurgicales. *Archiv. d'ophtal.*, Aug., 1910, p. 433.

[21]A. Critchett. Conical Cornea, Its Surgical Evolution. *Practitioner*, 1895, p. 426.

infection, and formation of anterior synechia, and at the present time has not been enthusiastically adopted.

Excision of a segment of the cornea from the base of the cone, as performed by Q. Roosbrock,[22] and *multiple punctur:ngs of the apex of the cone* with a fine cataract needle, as mentioned by Swanzy and Werner,[23] are other methods which have been employed from time to time. Little benefit seems to have accrued from the former of these procedures, although the latter method has some firm advocates. The punctures are made two or three times at each sitting, and may be repeated at intervals of a fortnight or more. A firm bandage is afterwards applied. Flattening of the cone is brought about by the formation of a network of cicatricial tissue without the production of much corneal opacity.

[For description of the use of the *Cautery in Keratoconus*, as well as an additional account of other forms of treatment, see Chas. A. Oliver's chapter in this System.—Ed.]

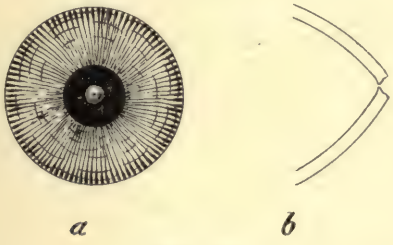


Fig. 488.

Cauterization of Apex of Cone. Loss of Tissue somewhat funnel-shaped with very small perforation.

A Resume of Non-Surgical Procedures Employed for the Relief of Conical Cornea.

As the antero-posterior axis of the eyeball is increased in conical cornea, there results a decided myopia. The conicity of the cornea is also responsible for high degrees of astigmatism; consequently a careful correction of the refractive error is imperative. This should be done at rather frequent intervals as the progress of the disease is responsible for repeated changes. Much care and practice are required in working out the refraction of these cases. A prolonged use of eserine with a pressure bandage has been said to benefit the condition, and as mentioned, the stenopaic disc at times improves vision. The use of astringent collyria has been from time to time recommended, as has the administration of iron and the iodin derivatives.

Indications for Surgical Intervention in Keratoconus.

It is only in the slight or moderate cases that much benefit is to be

expected from non-surgical procedures. In the more advanced cases the patient must submit to surgery if he is to expect much benefit. The degree of vision the patient possesses must be the index of operative interference. The writer's experience has led him to ally himself with the more conservative of his colleagues, and to recommend surgical intervention only in cases of an extreme character and in those patients whose vision has not been brought to a fair standard of usefulness by glasses. Just what that standard should be, must be decided by the individual surgeon. Where there is useful vision in one eye and the other is markedly defective, the writer would not be inclined to operate. Should the vision of both eyes be less than 6/60, he would advise an operation.

In the surgery of conical cornea it must not be forgotten that the nutrition of the parts to be operated on is, to say the least, precarious, so that extreme delicacy, care and precision are imperatively essential.

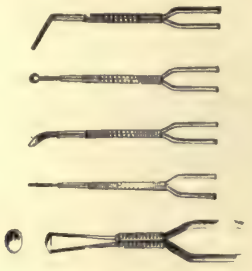


Fig. 489.
Knapp's Cautery Points for Conical Cornea.

Galvano-cautery is by far the most common procedure and is unquestionably the most satisfactory from every standpoint, although excision of the apex is still sometimes employed. Repeated puncturing of the cornea at the vascular limbus, in conjunction with the use of pilocarpine and the compression bandage, is also recommended.

Technique of Excision of the Apex of the Cone in Keratoconus.

The following is a description of Bader's operation as given by Higgins.[34]

The pupil is widely dilated with atropin, and the usual preliminary aseptic precautions are attended to. The eye is anesthetized with cocain solution and the speculum is inserted. The eye is steadied with fixation forceps in the hand of an assistant. The point of a thin Graefe knife is entered at the transverse meridian of the base of the cone and

[34]Higgins: On Eight Cases of Conical Cornea Treated by Elliptical Excision of the Apex. *Royal Lond. Oph. Hosp. Reports*, 1882, p. 316.

carried through the anterior chamber to a point opposite that of entrance. The knife is then brought outwards on the side of the cone. The small flap is picked up with iris forceps, and a second incision from without inwards completes the separation. A small opening tapering from both ends is the result, and if the incisions have been true the edges of the gap will exactly approximate. The iris in most instances will prolapse into the wound, in which case the healing will be slow and severe inflammation is likely to result.

To avoid the latter contingency, Badal[35] proposed a modification of the above procedure. Three horse-hair sutures were introduced vertically across the base of the cone, the central one of which was placed a little farther back than the other two. The elliptical flap was then removed as related above; the edges of the opening were approximated and the sutures tied. The author considers the use of horse-hair sutures as positively essential to the success of the operation, being easily and effectually sterilized. Every other material, including silk, has the disadvantage of inducing slight suppuration at the points of puncture.

TRANSPLANTATION OF THE CORNEA—KERATOPLASTY.

The operation of transplantation of the cornea or keratoplasty consists in the replacement of an opaque portion of corneal tissue by a clear section of this membrane. The procedure is indicated in cases of *leucoma,* where the cornea is so diffusely opaque that optical iridectomy would be of no avail. The corneæ of the lower animals, especially those of rabbits, are frequently used for transplantation, but most surgeons are agreed that the best results are obtained with the employment of living human cornea. The operation is known as *total* when the entire thickness of the cornea is removed preliminary to the insertion of the graft, and *partial* when only the layers down to Descemet's membrane are displaced. The few satisfactory results reported have been obtained when the latter procedure has been employed.

Historical Review of Corneal Transplantation.

The attempt to replace the opaque cornea by clear corneal tissue is a surgical procedure of comparatively modern date. Less than one hundred years ago, Reisinger[36] proposed to substitute the transparent cornea for the permanently opaque corneal substance. His experiments were conducted as early as 1818, and it is to him that credit for priority

---

[35]Badal. Trois Cas de Keratoconus, Resultats immediates et eloignés des interventions chirurgicales. *Archiv. d'ophtalm.* XXI, August, 1901, p. 433.

[36]Reisinger. Die Keratoplastie, ein Versuch zur Erweiterung der Augenheilkunde. *Bayerische Annalen für Abhadlungen, Erfindigen und Beobachtungen aus dem Gebiete der Chirurgie, Augenheilkunde und Geburtschülfe,* Vol. I, Part 1, p. 207. Sulzbach, 1824.

in this direction must be given. We are told that he successfully replaced the cornea of one animal with that of another, that adhesion promptly took place, and at the end of twenty days one-half of it was transparent.

Previous to Reisinger's time the treatment of leucomatous corneæ had occupied the thoughts of scientists and surgeons at least to some extent, for some time. In 1775, Robert Mead[37] recommended "the use of equal parts of powdered glass and sugar levigated into an impalpable powder." "A little put into the eye every day," he writes, "gradually absterges and wears off the spot by its inciting quality." Darwin,[38] in 1803, inquires if surgery could not be beneficially employed in these cases. He asks, "Could not a small piece of the cornea be cut out by a kind of trephine about the size of a thick bristle, or a small crow-quill, and would it not heal with a transparent scar? This experiment is worth trying and might be done by a piece of hollow steel wire with a sharp edge through which might be introduced a pointed steel screw, the screw to be introduced through the opaque cornea to hold it up, and press it against the cutting edge of a hollow wire or cylinder. If the scar should heal without losing its transparency, many blind people might be made to see tolerably well by this slight and not painful operation. An experiment I wish strongly to recommend to some ingenious surgeon or oculist."

Almost coincident with the publication of Reisinger's paper, Mössner[39] gave the results of his experiments, which led him to the conclusion that as corneal tissue would not heal to the area from which it was removed, that *a fortiori* it would not unite with any other. Schön,[40] a few years later, not only questioned the possibility of successfully transplanting corneal tissue, but vigorously opposed Reisinger's theory. His conclusions, however, seem to have been arrived at, not as the result of experimentation, but from pure conjecture.

Dieffenbach's[41] experiments which extended over a considerable period of time, were unsuccessful; as were those of Drolshagen,[42] Himley and Stilling,[43] which were carried on about the same time. In no

---

[37]Mead. *Medical Works of Robert Mead*, p. 410, Edinburgh, 1775.

[38]Darwin. *Zoonomia;* Second Am. Ed., p. 38, 1803.

[39]Mössner: De conformatione pupillæ artificialis. *Diss. Inaugural.*, Tübingen, 1823.

[40]Schön. Einige Worte über Keratoplastik. *Rust's Magazin f.d. gesammte Heilkunde*, Vol. XXIII, 1827, p. 342.

[41]Dieffenbach. Beiträge zur Verpflanzung der Hornhaut. *v. Ammon's Zeitschr. für Ophthal.*, Vol. I, Part II, 1831, p. 172.

[42]Drolshagen. *Dissertatio de vulnerabilitate oculi, accidunt experimenta quodam de transplantatione corneae*, Berlin, 1834.

[43]Himley and Stilling. *v. Ammon's Zeitschr. für Augenheilk.*, Vol. I, p. 93, 1834.

instance did the transplanted tissue unite perfectly, but in most cases contracted or sloughed, rendering the operations little less than failures.

Following this decade of fruitless experimentation, Wilhelm Thome[44] succeeded in attaining a moderate degree of success. His experiments numbered eight, and his results encouraged others to attempt further investigation. About this time Bigger[45] took up the work, carried on eighteen or twenty experiments, and expressed himself as well satisfied with the results.

He relates that the first time he had an opportunity of trying the experiment on one of the inferior animals was in 1835, a period when he was a prisoner with a nomadic tribe of Arabs 12 or 14 days' journey from Grand Cairo. The subject of the operation was a pet gazelle which had lost one eye from "inflammation," and the power of seeing with the other from a wound of the cornea. "The cornea was taken from another animal of the same species brought in wounded but not quite dead; adhesion took place, and ten days after the operation the animal gave unequivocal signs of vision, and the upper part of the transplanted cornea remained perfectly transparent."

The experiments above referred to were all confined to the transplantation of one animal's cornea to that of another lower animal. The first attempt to transfer the cornea of an animal to a human being was made in America, the first operation of this kind being performed by Kissam,[46] of New York. He reports that in 1838 he transplanted a portion of the cornea of a pig, six months' old, to the eye of a man who was practically blind from a central leucomatous cornea.

He relates that he was led to perform this operation from reading the account of Bigger's experiments just related. He employed a Beer's knife to remove a portion of his patient's cornea and attached the animal's cornea by means of two ligatures to points on a line with the angle of the tarsi. Vision improved immediately after the operation, but within a fortnight the cornea became opaque, and in the course of a month the attached portion was absorbed.

Almost simultaneous with Kissam's report, Wutzer,[47] of Bonn, published an account of a case in which he transplanted the cornea of a living sheep to the eye of a human subject. The transplantation succeeded, but the cornea shortly became completely opaque.

---

[44]Thome. *De corneæ transplantatione.* Diss. inaugural., 1834.

[45]Bigger. An Inquiry into the Possibility of Transplanting the Cornea with a view of Relieving Blindness (hitherto deemed incurable) caused by Several Diseases of that Structure. *Dublin Jour. of Med. Science*, July, 1837, p. 408.

[46]Kissam. Keratoplastice in Man. *New York Journal of Medicine*, March, 1844, p. 281.

[47]Wutzer. Quoted by Feldman. Mémoire sur la Keratoplastie. *Archives Générales de Médicine*, May, 1844, p. 1.

In 1830 the Medical Faculty of Munich offered a prize for the best work on keratoplasty, and much of the experimentation which followed during the next decade may possibly be attributed to this stimulus.

Ranier de Schallern,[48] Muhlhauer,[49] Königshofer,[50] Marcus,[51] Munk,[52] Hauenstein,[53] Himley,[54] and Feldman[55] were among those who contributed papers relating to the subject. de Schallern devised a pneumatic machine in the form of a cylindrical tube, which he employed in the operation.

That Marcus, at that date, possessed a clear conception of the operative essentials of the procedure is shown by the rules which he formulated, viz., 1. An exact correspondence in the size and form of the graft and the opening is essential. 2. The graft must be rapidly transferred. 3. There must be ready fixation of the graft. 4. The internal structures of the eye must be prevented from being pushed forwards through the opening in the cornea.

Feldman conducted about twenty careful experiments on animals, in all of which, he states, the corneæ became not only opaque but more or less irregular on their surface. Plouvier,[56] after trying the operation on animals many times, grafted the cornea of a dog to that of a girl blinded by smallpox. The graft was secured by four sutures, became satisfactorily engrafted, but in a short time lost its transparency. Desmarres'[57] attempts were likewise unsatisfactory.

In 1853 Nussbaum[58] proposed making an opening in the opaque cornea and inserting a small piece of glass in the shape of a shirt-stud, hoping that it would be retained permanently and aid vision.

From 1853 to 1872 little was apparently done to further success along this line. In the latter year Power[59] revived the subject of kera-

---

[48]Ranier de Schallern. *Ueber Pflanzung der Hornhaut, Diss. Inaugural.*, Munich, 1830.

[49]Muhlhauer. *Ueber Transplantation der Cornea; Diss. Inaugural.*, Munich, 1840.

[50]Königshofer. De Transplantatione corneæ; *Dissertation inauguralis*, Monaco, 1841.

[51]Marcus. Angabe eines Operations-verfahren zür Ausführung d. Transplantatio Corneæ. *Schmidt's Jahrb.*, XXIX, 1841, p. 89.

[52]Munk: Die Keratoplastik, eine Operationsmethode am Blinden, die am unheilbaren Centralleucom oder am globosen Hornhautstaphylom leiden, das Sehvermögen wiederzugeben, Hamburg, 1840.

[53]Hauenstein: Ueber die Transplantatione der Cornea, *Diss. Inaug.*, Sulzbach, 1843.

[54]Himly. *Krankheiten und Missildungen des menschlichen Auges*, Vol. II, p. 60, 1843.

[55]Feldman. Mémoire sur la Keratoplastie, *Archiv. Général. de Medicin*, May, 1844, p. 1.

[56]Plouvier. Keratoplastie; *Gaz. des Hôp.*, August 21, 1845, p. 386.

[57]Desmarres: *Traité théoretique et pratique des Maladies des Yeux*, Vol. II, p. 339, 1847.

[58]Nussbaum. *Zeitschr. für Wissenshaft, Zöologie*, Vol. V, p. 172, 1852.

[59]Power: On Transplantation of Cornea. *Report of the Fourth Internat. Ophthal. Congress*, 1872, p. 172.

toplasty at the International Ophthalmological Congress. His report included experiments on 3 dogs, 3 cats, 4 rabbits, and 2 human beings. The two last cases were children who had extensive staphylomatous protrusion of the cornea as the result of purulent ophthalmia. In both the cornea was of remarkable thickness, not less than ⅛ inch. Power employed a sharpened brass Mohr's cork-borer in his operations. He reports that he had more or less success in all his cases. In the human cases union occurred by first intention and without irritation or suppuration. No sutures were employed. The transplanted tissue remained transparent or semi-transparent for some time.

In 1878 von Hippel[60] published the results of his experiments on the lower animals and his conclusions were that the subject of keratoplasty was worthy of further investigation. It is to this observer that great credit is due for the ingenious invention of the corneal trephine which has been of such aid in the perfection of this operation. This instrument is later described in this chapter.

Dürr[61] in 1877 proposed transplanting a portion of the cornea to which was attached a narrow strip of conjunctiva and sclera, the latter to serve as a flap to be attached by sutures to the surrounding parts. The transplanted pieces of cornea that he used were 5 to 8 mm. long, 5 to 6 mm. broad and 1 mm. thick, and were covered with epithelium.

Wolfe[62] transplanted a portion of human cornea and employed flaps dissected from the surrounding conjunctiva to assist in retaining the transplanted portion in place, the grafts "adhering like adhesive plaster."

De Wecker[63] employed a trephine by which he removed a piece of cicatricial cornea and replaced it by a similar portion cut from the clear cornea of an enucleated eye. He expressed himself to the effect that "we have no right in these cases to refuse the slightest aid to sufferers who have but this one remaining chance to recover a little sight; neither should we be deterred by the reproach of eccentricity which will certainly be leveled at anyone who shall attempt to graft a cornea."

In 1887 Adamük[64] reported some experiments which he had conducted on fowl's eyes. He considered it important, as did Dürr, that some of the neighboring sclerotic should be transplanted with the cor-

---

[60]von Hippel: Ueber Transplantation der Corneæ. *von Graefe's Archiv. für Ophthal.*, XXIV, 1878, p. 235.

[61]Dürr. Neue Versuche ueber Keratoplastik. *Klin. Monatsbl. fuer. Augenheilk.*, Sept., 1877, p. 205.

[62]Wolfe. On Corneal Transplantation. *Medical Times and Gaz.*, Nov. 22, 1879, p. 579.

[63]De Wecker. *Ocular Therapeutics, English Translation*, p. 145, London, 1879.

[64]Adamük. Zur Frage ueber die Transplantation der Cornea. *Klin. Monatsbl. fuer Augenheilk.*, 1887, p. 51.

neal graft in order that the highest degree of nourishment might be maintained.

Johnson's[65] experience with four cases in which he engrafted rabbits' cornea upon human subjects was to the effect that while the grafts fixed themselves and grew to the surrounding tissues without any difficulty, their vitality seemed gradually to decline, as shown by the progressive loss of transparency and by the absence of feeling when touched. They finally became red and opaque, lost their individuality, seemed to dwindle away, and at the end of three months it was impossible to say from the appearance of the eye that a corneal graft had been made. Fox,[66] in 1888, reported the case of a girl of 19 with opacities of both corneæ, the sequel of a pronounced keratitis, in which, two months after grafting, the vision was considerably improved and the transparency of the transplanted cornea was progressing.

In 1888 von Hippel,[67] who for ten years previously had made hundreds of experiments on animals and human subjects and who was unquestionably the first to successfully transplant a portion of corneal tissue to a human being and have it permanently retain its transparency, called attention to an important feature of the subject of keratoplasty which to that time had not been duly considered. Many experimenters had successfully transplanted corneal tissue, but in every recorded case the graft had sooner or later lost its transparency. Acting on the suggestion of Leber, who first directed attention to the fact that the transparency of the cornea depends upon the integrity of the epithelium lining Descemet's membrane and that disturbance of the latter through entrance of the aqueous humor leads to edema and opacity of the adjacent tissue, von Hippel *abandoned the idea of replacing the entire thickness* of the cornea and stopped short of the removal of those protecting structures. In the first three cases in which he employed the new procedure he met with failure, the graft becoming opaque. This he attributed to faulty technic, undoubtedly due to traumatism of the graft in dissecting it from the animal (a dog) which he employed. He then decided to remove the graft from a smaller animal, that the entire thickness of the cornea might be removed. This attempt was successful and the graft retained its transparency. The patient, whose vision was increased from the counting of fingers at 2 meters to 20/200, was exhibited at the meeting of the Ophthalmological Society in Heidelberg in 1886 and 1887.

---

[65]Johnson. On Four Cases of Cornea Grafting. *British Med. Jour.*, Dec. 18, 1886, p. 1209.

[66]Fox. Corneal Transplantation. *The Med. and Surg. Reporter*, July 21, 1888, p. 72.

[67]von Hippel: Eine neue Methode der Hornhauttransplantation, *Von Graefe's Archiv. fuer Ophthal.*, XXXIV, I, 1888, p. 108.

Wagenmann[68] approved the method of von Hippel and laid especial stress on the importance of extreme gentleness in handling the graft, both in its incision and its replacement.

Chisolm [69] declared that the *sine qua non* of a suitable case for operation is a perfect elastic membrane of Descemet and a normal anterior chamber filled with aqueous.

Baker[70] reported a number of experiments on rabbits by Wolfe's method. When the operation was carefully performed, the cornea united and remained clear for one or two weeks, after which it gradually became opaque; the eye usually became soft and *phthisis bulbi* resulted. The results were so discouraging as to deter him from attempting the operation on the human eye. He cites the interesting case of a man "into whose eye he inserted a glass button, which was retained for two years without causing any particular trouble." There was temporary improvement of vision, but the globe eventually became soft and shrunken. The patient was a druggist whose eyes were injured by an explosion while charging a soda fountain. Both corneæ sloughed as a result of the accident.

Gradenigo[71] is quoted as successfully transplanting the cornea from the eye of a barn fowl into the eye of a human subject. On the eighth day after the operation the transplanted cornea is said to have presented "quite a pellucid and convex appearance."

Fox[72] also attempted to transplant the cornea of a chicken, but the result was not satisfactory, the transferred cornea becoming shrunken and opaque.

W. F. Smith[73] reported the transplantation of a portion of a rabbit's cornea to the eye of a woman, who was practically blind as the result of small-pox, which partially retained its transparency at the end of 15 months. He employed a simple trephine which he had constructed. His experience covered five attempts at transplantation, and the instance cited was the only one that approached success.

Fuchs,[74] who had conducted more than fifty experiments on animals, expressed the belief that the operation is justifiable in certain cases.

---

[68]Wagenmann: Experimentelle Untersuchungen zur Frage der Keratoplastie, *Archiv. fuer Ophthalmologie*, XXXIV, I, 1888, p. 211.

[69]Chisolm: The Transplantation of a Rabbit's Cornea Into the Human Eye. *The Medical Record*, January 5, 1889, p. 13.

[70]Baker. Some Remarks on Transplantation of the Cornea and Allied Subjects. *American Journal of Ophthalmology*, January, 1889, p. 1.

[71]Gradenigo. Quoted in *The Lancet*, June 29, 1880, p. 1319.

[72]Fox. *A Practical Treatise on Ophthalmology*, p. 222, New York, 1910.

[73]Smith. Case of Corneal Transplantation from the Rabbit's to the Human Eye; Result not very Favorable. *Archives of Ophthalmology*, Vol. XIX, No. 253, 1890, p. 136.

[74]Fuchs: Zur Keratoplastik, *Zeitschr. fuer Augenheilk.*, Vol. V, 1901, p. 1.

In 1907 O'Meara[75] described a procedure which he believed to be superior to the use of the trephine. Under cocain anesthesia he transfixes the opaque cornea with a Graefe knife and cuts off a superficial slice of opaque area, repeating the process and employing the knife to make the half section after transfixion until the opaque tissue is removed. A dog is then rapidly killed with chloroform. Three or four sutures of fine silk are passed through its cornea at equal distances around the margin of the membrane. The canine cornea is then dissected out in its entirety, placed in position on the raw human cornea (after the parts have been carefully dried) and secured to the conjunctiva by the sutures. If the anterior chamber is opened and the aqueous escapes, the operation is postponed and the eye closed for a few days, when the surface is again freshened. O'Meara believes that the advantage of this operation lies in the fact that one can, while operating, more definitely determine the depth of the incision in the cornea than is possible with the trephine.

Zirm[76] has reported an exceptionally successful case of keratoplasty. His patient was a man of 45, whose corneæ were almost entirely opaque as the result of a burn by unslaked lime. Vision was reduced to the perception of hand movements. With von Hippel's trephine a disc of clear cornea was removed from the cornea of a boy of 11 years, whose eye had been lost by a fragment of steel, and transplanted the disc to his patient's eye. It was retained by two sutures placed in the conjunctiva and drawn across the cornea in the form of a St. Andrews' cross. Care was taken not to touch the corneal disc with forceps, scissors or knife. The graft healed kindly, and in a subsequent article Zirm[77] reports that the patient continued to improve so that more than a year after the operation vision was 6/36 with a stenopaic disc, and with convex glasses (16 to 20 D) patient could read Jaeger 4, with difficulty. Zirm considers the following points essential to a successful operation: 1. The exclusive employment of human cornea for the graft, preferably the cornea of a healthy young person. 2. The exclusive use of von Hippel's trephine and the instillation of eserin if the anterior chamber is present. 3. Profound anesthesia during the operation, strict asepsis and the avoidance of antiseptics. 4. Protection of the graft between pieces of gauze moistened with sterile physiological salt solution kept warm by steam. 5. Retention of the graft in position by two sutures attached to the conjunctiva and forming a cross over it. 6. Selection of cases.

---

[75]O'Meara. The Operation of Transplantation of the Cornea. *Indian Medical Gazette*, March, 1907, p. 96.

[76]Zirm. Eine erfolgreiche totale Keratoplastik. *Archiv. fuer Ophthal.*, LXIV. 3, 1906, p. 580.

[77]Zirm. Ueber Hautpfropfung. *Wein. Klin. Wochenschr.*, Jan. 17, 1907, p. 61.

Valk,[78] from experience of 3 cases, believes the operation of keratoplasty fully justifiable. It may be tried in all cases of *leucoma totale* and of dense pannus following old trachoma after the cicatrical stage has passed.

Lesser[79] reports the case of a man, 24 years old, whose vision, perception and projection of light, improved to the counting of fingers at 12 inches three months after he had transplanted a disc of cornea from a rabbit to his patient's cornea. von Hippel's trephine was used and the cornea was removed only to Descemet's membrane.

Plange[80] published the report of a case in which, several months after operation, the vision of his patient equaled the counting of fingers at four meters.

Calderaro[81] removed a small circumscribed tumor from the cornea of a woman of 66 and transplanted a disc from the eye of a woman of 52, blind from absolute glaucoma. The trephine of von Hippel was used, and he held the transplanted portion of cornea in position by gentle finger pressure for fifteen minutes, a procedure to which he attributes much of the success he attained in the case. Thirty days after, the patient's vision had improved to 1/20.

The result of all this experimentation appears to be the complete success of the operation in two well-authenticated cases, those of von Hippel and Zirm. In both transparency of the cornea remained for a period of more than one year, which would seem to indicate the permanency of the results.

Indications for Corneal Transplantation and the Essentials of Operative Success.

From the experience of those who have given much time and labor to experiments in keratoplasty, it will readily be noted that the field for this operation is rather a limited one, and the prospects of success are not particularly encouraging. In the first place, the surgeon would not for a moment consider the performance of the operation in a case where optical iridectomy would offer the slightest possibility of success. On the other hand, the chances for success seem to be exceedingly slight in those cases one so frequently sees, in which, as the result of purulent ophthalmia, the cornea is staphylomatous, markedly thickened and white; and, as a result of perforating corneal ulcer the anterior chamber is to a greater or less extent

---

[78]Valk. The Operation of Grafting the Rabbit's Cornea on the Human Eye. *Am. Jour. of Surgery*, Jan., 1908, p. 9.

[79]Lesser. A Keratoplasty. *Medical Record*, Sept. 12, 1908, p. 447.

[80]Plange. Ueber einem Fall von Hornhauttransplantation mit erhaltener Transparenz. *Klin. Monatsbl. fuer Augenheilk.*, March, 1908, p. 277.

[81]Calderaro. La transplantation de la Cornea. *Clinica Oculistica*, Sept., 1908, p. 436.

abolished and the iris is entangled in the corneal cicatrix. A clear, intact and elastic Descemet's membrane seems to be essential to a successful operation. Such a condition is not uncommonly encountered in corneæ that have been the subject of *superficial ulceration, severe pannus, burns by lime or other cauterants, and the opacity resulting from the encroachment of growths.*

The operative maneuvers must of necessity be exceedingly delicate, and scrupulous attention must be paid to the details of general surgical technique. No one should consider operating on the human subject until he had thoroughly mastered the details of procedure by experimentation on the lower animals. The employment of the trephine of von Hippel is, in the writer's opinion, essential to successful operation.

Description of Von Hippel's Trephine.

This ingenious instrument consists essentially of a tube in which

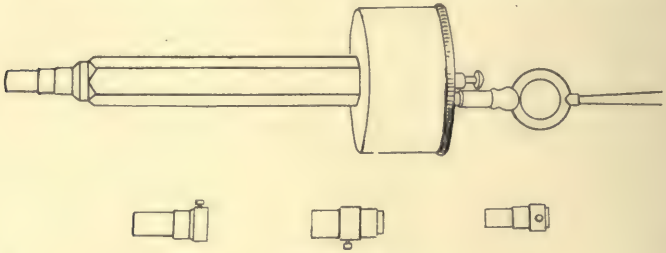


Fig. 490.
Von Hippel's Trephine.

is enclosed a circular knife whose cutting edge is protected by a collar which controls the depth of the incision. At the opposite end is a spring which, when released by pressure on a small button, sets the knife in rotation. There are usually two or three circular knives of various diameters accompanying the set. The spring attachment is wound by a key. The instrument is arranged so that the knife may be "set" for cutting various depths.

Von Hippel's Operation.

The instruments required are an eye speculum (or a pair of lid retractors), fixation forceps, the trephine, a Graefe knife, and a pair of iris forceps.

Cocaine anesthesia is commonly employed. The lids being well separated, the globe is steadied and the trephine is applied with gentle pressure at a right angle to the cornea over the opaque area it is desired to remove. The trepan has previously been set to cut the estimated depth which of necessity requires the removal of the tissue

down to, but not including Descemet's membrane. The button at the top of the instrument is touched by an assistant and the knife being released, rotates automatically. The trephine is then removed and the trephined portion is carefully dissected off by the aid of an iris forceps and Graefe knife, leaving the membrane of Descemet exposed. This step in the operation is a decidedly delicate one and aims at leaving as thin a posterior layer of cornea as possible, at the same time removing a disc of equal thickness throughout. The third step of the operation consists in the excision, with the same trephine, of

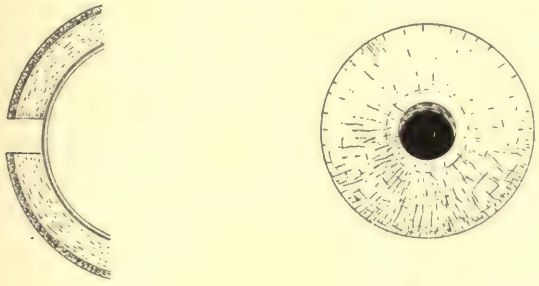


Fig. 491.

Von Hippel's Trephine.

(a) Profile of Cornea Showing Layers with Disc Removed Down to Descemet's Membrane; (b) Front View of Cornea Showing Disc Transplanted.

a piece of the cornea either of a rabbit or of a human being. In this procedure the incision must go *completely through the entire thickness* of the cornea. The corneal disc thus incised is placed over the trephined area of the patient's cornea and gently pushed out of the trephine by a delicate wire probe which passes through the instrument into the corneal opening. It is thus seen that the graft is touched by no instrument except the trephine itself. It does not matter if the surface of the graft lies a little below the plane of the cornea, but if it protrudes above the surface it is liable to become displaced. Powdered iodoform is usually dusted over the cornea and a moderately firm bandage is applied. The eye should be inspected at the end of two or three days, and after that the dressing may be changed daily. Healing is usually complete in three weeks.

There is usually moderate hemorrhage when the leucomatous tissue is incised. This is best arrested by the use of pledgets of cotton soaked in bichlorid solution cooled on ice. If thought best, in the judgment of the surgeon, the graft may be kept in place by the aid of sutures extending across the cornea in the form of a cross as suggested by Zirm.

CHAPTER VI.

IRIDECTOMY, IRIDOTOMY AND SOME ALLIED OPERATIONS.

By ADOLF ALT, M. D., St. Louis, Mo.

General Remarks—Historical Data—Instruments Required for Iridectomy—Method of Making an Artificial Pupil—Accidents During the Operation—Defects in the Corneal Incision—Wounding the Iris, Lens and Suspensory Ligament—Too Rapid Outflow of the Aqueous Humor—Hemorrhage—Iridodialysis—Firm Adhesion of the Uveal Pigment to the Anterior Lens Capsule—Healing after Optical Iridectomy—Further Indications for Iridectomy—Preparatory to Cataract Extraction—Therapeutic Iridectomy—Iridectomy in Glaucoma—Iridectomy in the Sequelæ of Iritis—In Corneal Ulceration—The Removal of Tumors of the Iris—Iridotomy—Historical Data—Iridotomy in Modern Times—De Wecker's Iridotomy—Simple Iridotomy—Double Iridotomy—Permanency of the Result—Iridotomy with Knives or Knife-needles—General Considerations—Iridoectomy—General Considerations—Iridodialysis — Operations for the Relief of Synechiæ—Iridorhexis—Iridenkleisis and Iridodesis—Iridenkleisis in Traumatic Iridodialysis—Iridolysis or Sphincterolysis (Corelysis)—General Considerations—Posterior Iridolysis—Anterior Iridolysis—Temporary Resection of the Corneal Scar.

IRIDECTOMY.

General Remarks.

Iridectomy, the excision of a piece of the iris, is one of the most important operations performed on the eye. The indications for it vary considerably.

Originally it was designed and performed only to make an artificial pupil, that is, for optical purposes. The object of an optical iridectomy is to permit light to penetrate into the interior of an eye in which the pupillary area for some reason is not sufficiently transparent for this purpose. The obstructing opacity may lie in the cornea, or in the space of the pupil, or in the crystalline lens, and be of a permanent or progressive character. As was later on found, an iridectomy may, also, be a curative agent, especially in eyes with increased intraocular tension, or in cases in which for a time at least it seems useful to reduce the intraocular tension, as for instance, in ulceration of the

cornea, in certain sequels of iritis, and for the removal of tumors of the iris.

Historical Data.

The excision of a piece of iris was practised occasionally in some cases of cataract extraction by Daviel.[1] A kind of iridectomy for purely optical purposes was first introduced by Wenzel.[2] However, he made only subcorneal iridectomies. This led frequently to an injury to the lens purposes was first introduced by Wenzel.[2] However, he made only and cataract formation. In consequence his advice was to extract the lens at once after iridectomy, whether it was opaque or not.

Beer[3] was the first to introduce into ophthalmic surgery the abscision of the iris outside of the eye, the *precorneal iridectomy*. To him belongs the credit of having invented and practised iridectomy as we still perform it. That since his time the procedure has been improved upon and that its field of usefulness has been greatly enlarged, especially by von Graefe, does not alter this fact. He made a corneal flap with the triangular knife which bears his name, then he drew the iris out of the wound by means of a sharp cataract hook and quickly snipped it off with scissors, and this, in a general way, is still the method of performing precorneal iridectomy nowadays.

Instruments Required for Performing Iridectomy.

The instruments necessary for executing an iridectomy are the following:

(1). Some form of blepharostat (lid-holder).
(2). Fixation forceps.
(3). A lance-shaped knife or a von Graefe knife.
(4). Some form of iris forceps or a blunt hook.
(5). Some form of iris scissors.
(6). A thin spatula.

Method of Making an Artificial Pupil.

Whether it is best to dilate the pupil with a mydriatic or not before an iridectomy is made depends on certain circumstances. It is surely contra-indicated in cases with an increased intraocular tension. It may be of value when otherwise it would be impossible to see the pupillary edge. In other cases, like in zonular cataract, for instance, the writer has found it of decided advantage. In such cases it is best to dilate the pupil only in order to find out whether vision is increased

---

[1]Daviel. De Wecker. Réminiscences historiques concernant l'extraction de la cataracte. *Arch. d'Ophtalmologie*, V. XIII, 1893.

[2]Wenzel. Traité de la cataracte, etc. Also in German, Nuernberg, 1788, p. 188.

[3]Beer. Ansicht der staphylomatoesen Metamorphosen des Auges and der kuenstlichen Pupillenbildung, Wien, 1806.

thereby and to determine the best location for an iridectomy, and then to let the pupil contract before operating.

The eye should be well anesthetized by one of the local anesthetics, to which a drop of adrenalin or a similar blood-vessel contracting agent may be added. In children and very nervous people it is better to operate with general anesthesia.

The operator usually stands behind the head of the prone patient and somewhat to one side. However, no fast rule can be laid down

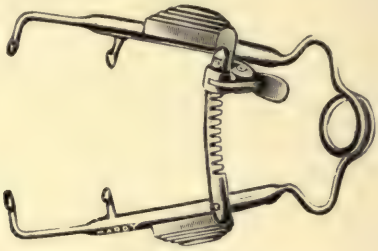


Fig. 492.
Landolt's Blepharostat.

as to this, since the main object must be that the operator sees the field of operation well and that everything is handy to him. This again depends on the situation of the opacity for which operation is made, or rather on the site of the transparent part which is to be made use of, on the form of knife which is employed, and on whether the operator is ambidextrous or not.

The lids are held separated by a blepharostat. The conjunctiva is grasped with fixation forceps near the corneo-scleral margin, either below, or somewhere at the corneal periphery directly opposite to the

Fig. 493.
Fixation Forceps.

intended incision, or at a point near the latter. Then the corneal incision is made.

For making the corneal incision the majority of operators use a lance-shaped knife the blade of which is bent at an angle on the flat. In the region of the palpebral fissure and on the temporal side of it a straight lance knife can be made use of.

When the bent lance knife is used, care should be taken to enter its point at the point where it is most desirable. This seems easy, yet a slight twisting motion of the eye may change the point of entrance enough to displace the desired point of puncture. It is well, therefore,

to pay attention to some landmark on the eye, such as a conjunctival blood-vessel or a spot on the cornea or in the iris.

The size of the incision depends on the width of the knife and the depth to which it is pushed into the anterior chamber. The knife selected should be broad enough to produce an incision which is large enough to allow of an easy introduction of the iris forceps or iris hook. For an optical pupil this incision should not be longer.

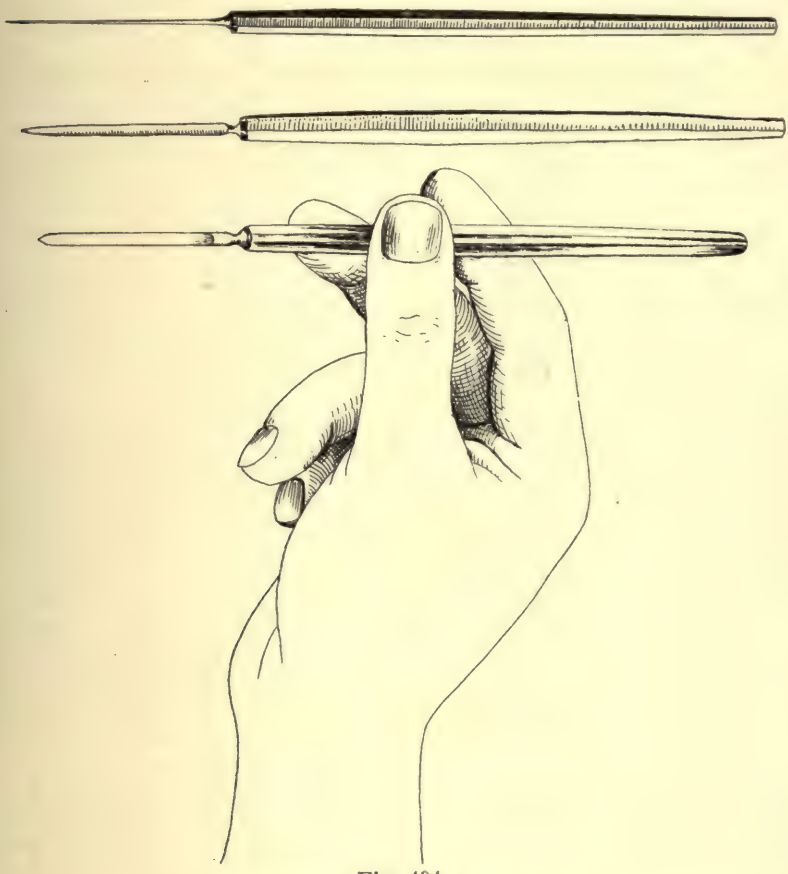


Fig. 494.
Von Graefe Knife and How to Hold It.

Another point to keep in mind is that the corneal incision must be placed so that it is possible to draw the iris out and cut it off. When there is little space left to operate in this is sometimes quite difficult. In a general way there should be a distance of at least 1 to 2 mm. between the corneal incision and the portion of the iris which it is intended to withdraw.

It is best in most cases to enter the point of the lance knife at the corneal limbus. When making the puncture, it is advisable to hold the knife so that the blade goes through the cornea in the direction of a largest circle. This will help to make the wound canal shorter than if the knife passes through the cornea in any other direction.

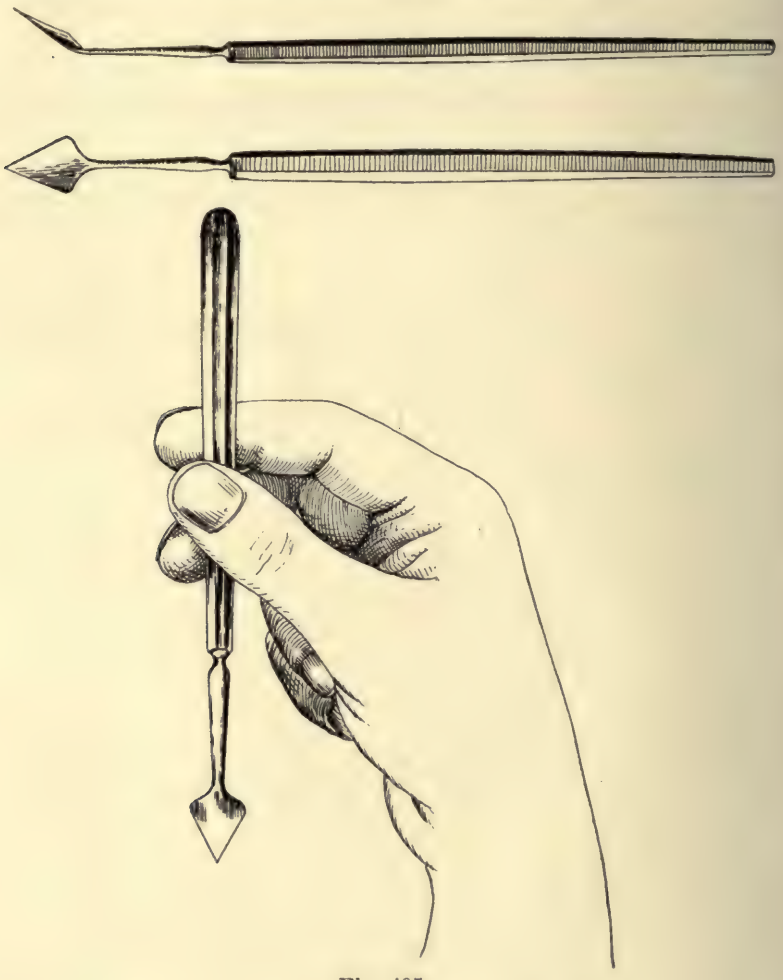


Fig. 495.
Lance-shaped Knives and How to Hold Them.

As soon as the point of the knife has penetrated the cornea and is seen to enter the anterior chamber, the handle of the knife is slightly depressed backwards so as to make sure that the point does not wound the iris. When the proper position of the knife has been obtained, it is gently pressed farther into the anterior chamber in front of and

nearly parallel with the iris, till the point has reached the desired depth. The lance knife being of the right width, it is not likely that its point will injure the cornea on the opposite side. Yet, it is well to watch the point carefully.

The lance knife is then *gently* withdrawn. In doing this the operator should depress the handle of the knife a little farther backwards to insure perfect safety to the lens and iris. During this act the point of the lance knife may glide along the posterior surface of the cornea. A slight scratching of the endothelium on Descemet's membrane, while not desirable, seems to do no lasting harm. With a little care, however, even this may be usually avoided.

The withdrawal of the knife should be made steadily and without haste, so as to prevent too rapid an outflow of the aqueous humor.

Since the inner wound of the corneal incision, when it is made with a lance knife, is always smaller than the outer one and this difference in size is the greater the more obliquely the knife has been allowed to cut through the cornea, it may be well, and often is necessary, to correct this condition by a slight lateral motion while the knife is withdrawn.

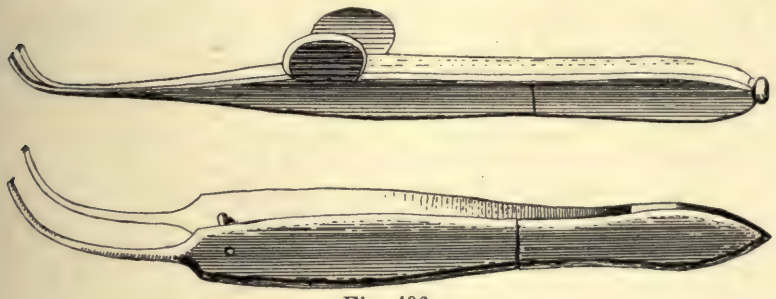


Fig. 496.
Iris Forceps.

When the conditions of the case in hand allow of it, the point of the lance knife in making the incision should be entered exactly at the corneal limbus, or slightly in front of it, so as to avoid a possible hemorrhage from the conjunctival blood-vessels which might enter the anterior chamber and obscure the field of operation. As, however, an optical iridectomy has for its object to procure vision, and as the obstacles to vision which it is to overcome vary considerably, the artificial pupil must be placed where the best possible visual result can be obtained. The place of the corneal incision must, therefore, not infrequently be situated in the corneo-scleral tissue or at some other part of the cornea where it will serve the purpose best.

The best lance knives are made differing in width and in the angle

between the blade and shaft. It is, however, a good rule for one operator to use lance knives with the same angle for all widths.

While a great many operators adhere strictly to the use of the lance knife when making an iridectomy, others, like the writer, almost as a rule prefer the narrow von Graefe knife. The use of this knife in making the corneal incision is of decided advantage when the anterior chamber is shallow or partially obliterated, as for instance, in cases of anterior synechia, tumor of the iris, etc.

When the von Graefe knife is used, its point is made to penetrate the cornea at the corneal limbus or near it and after having entered the anterior chamber is pushed forward to the previously selected place

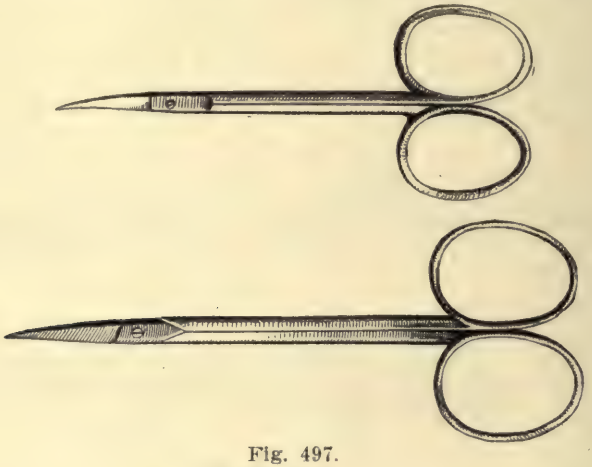


Fig. 497.
Iris Scissors.

of counter-puncture. When the anterior chamber is comparatively deep, this procedure offers no difficulty. When, however, the anterior chamber is very shallow, it will require a deft hand and some ingenuity to push the knife between the posterior surface of the cornea and the anterior surface of the iris, which latter in these cases is usually quite uneven, without wounding the membrane. It is then necessary to make slightly undulating and sawing movements with the point of the knife, while it is gradually being pushed onward, so as to avoid the elevated parts of the iris tissue and to make use of the depressed ones. When the point has reached the place where it is intended to make the counter-puncture, it is pushed through the cornea and the incision is finished by cutting through the tissue between puncture and counter-puncture, either by simple pressure or by a sawing motion.

In cases in which there is not enough space left between the cornea and iris to enter and pass even a narrow von Graefe knife, it may be-

come necessary to cut the cornea from without inwards instead of the ordinary manner of cutting from within outwards, as in the procedure just outlined. This may be done by means of any knife. Gayet[4] recommended for this manœuvre a Desmarres scarificator. S. M. Burnett[5] used a von Graefe knife. As soon as the anterior chamber is opened some aqueous will escape. The knife is then changed for blunt-pointed scissors or a blunt-pointed knife with which the section can be more readily completed.

A corneal incision by any of the foregoing methods having been completed, the next step in the operation consists in grasping the iris and drawing it out through the corneal opening.

This may be, and is usually, done by means of one of the many forms of iris forceps, or by means of a blunt Tyrrell hook.

For the success of this, the most delicate manœuvre in eye operations, a great deal depends on the iris forceps. The branches of the iris forceps while they must be thin must not be too elastic, since the iris forceps should bite only with the teeth at the very end of the branch. It is well, therefore, to examine the forceps carefully before use and to pay especial attention to the teeth which must be perfectly

Fig. 498.
Spatula.

smooth and come freely and easily apart when the pressure is released. Iris forceps lacking these qualities will grasp parts of the iris tissue which it is not desirable to include in the bite and interfere with a clean operation.

When the pupil is almost totally occluded or there is an extensive posterior synechia it may be of decided advantage to use some form of iris forceps in which the branches make a rotary motion around the handle to which they stand nearly at right angles, like the Mathieu forceps. In these the biting teeth are close to the under surface of the branches.

The forceps, being held like the knives with the tips of the thumb, index and middle finger, is entered through the corneal incision with the blades firmly closed and its tip moved carefully into the anterior chamber and forward as far as necessary to reach the part of the sphincter edge of the iris where it is intended to grasp it.

When this point has been reached the pressure exerted on the blades by the fingers is relaxed sufficiently so as to permit the biting

[4]Gayet. *Lancet*, Vol. II, 1875, p. 561.
[5]Burnett. The manner of making an Iridectomy in Acute Glaucoma. *Amer. Journ. of Ophthal.*, Apr., 1902, p. 14.

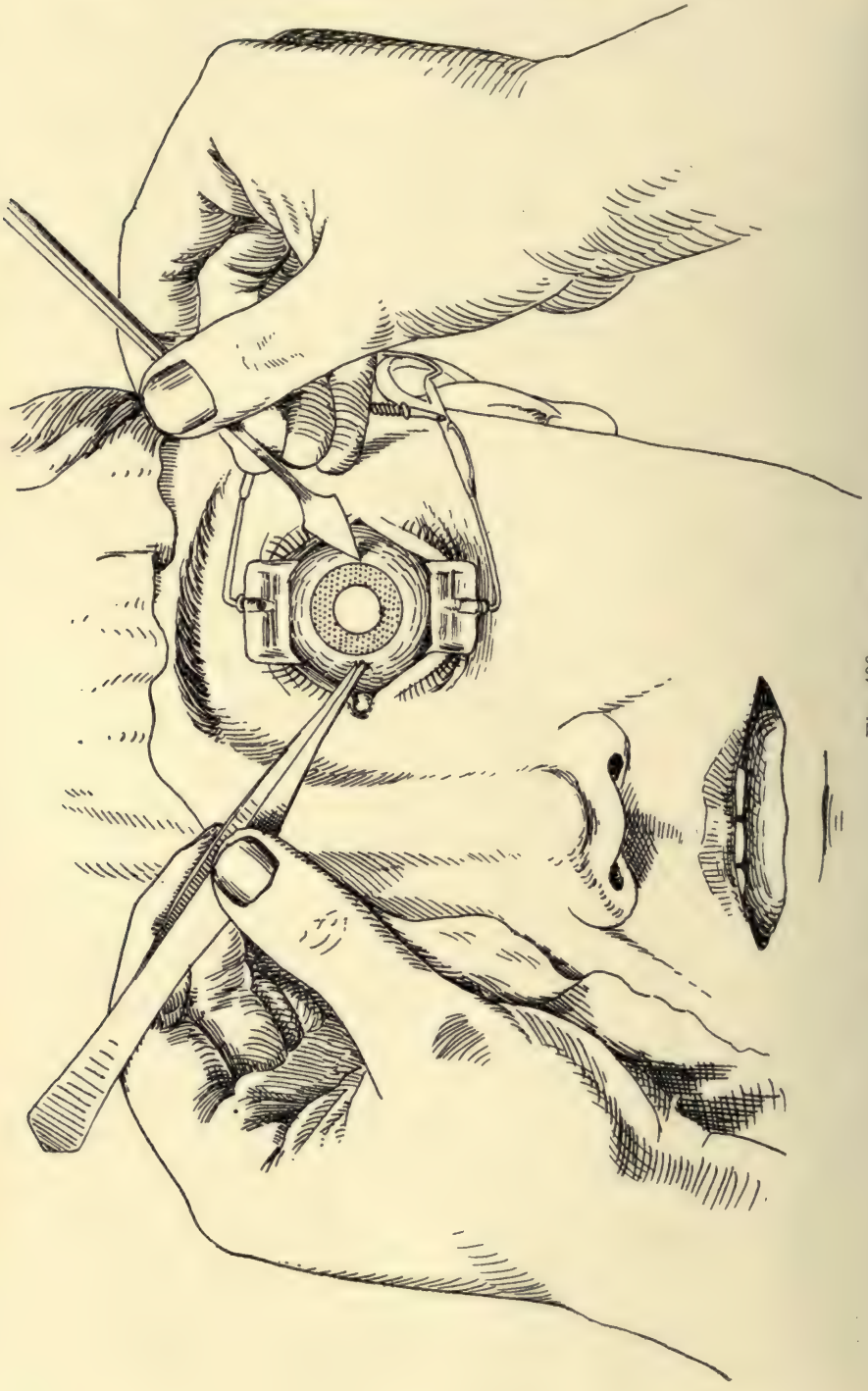


Fig. 499.
Incision with the straight lance knife (after Valude).

ends to separate, and by being shut again to hold the iris tissue in a firm grasp. Care must be taken to do this without taking hold of the whole thickness of the iris, or even to grasp the lens capsule. After this the iris is gently drawn out through the corneal incision. Some operators prefer the use of a blunt hook to get hold of the pupillary edge of the iris and to draw it out. Of course, such a hook must be

Fig. 500.
Incision with the Bent Lance Knife (after Beard).

small and absolutely smooth so as to guard against wounding the lens capsule. There is greater danger of producing such an injury with a hook which must pass in between the pupillary edge of the iris and the anterior lens capsule, than there is with the iris forceps. On the other hand, a hook can be entered through a very small corneal incision and is felt less disagreeably by the patient.

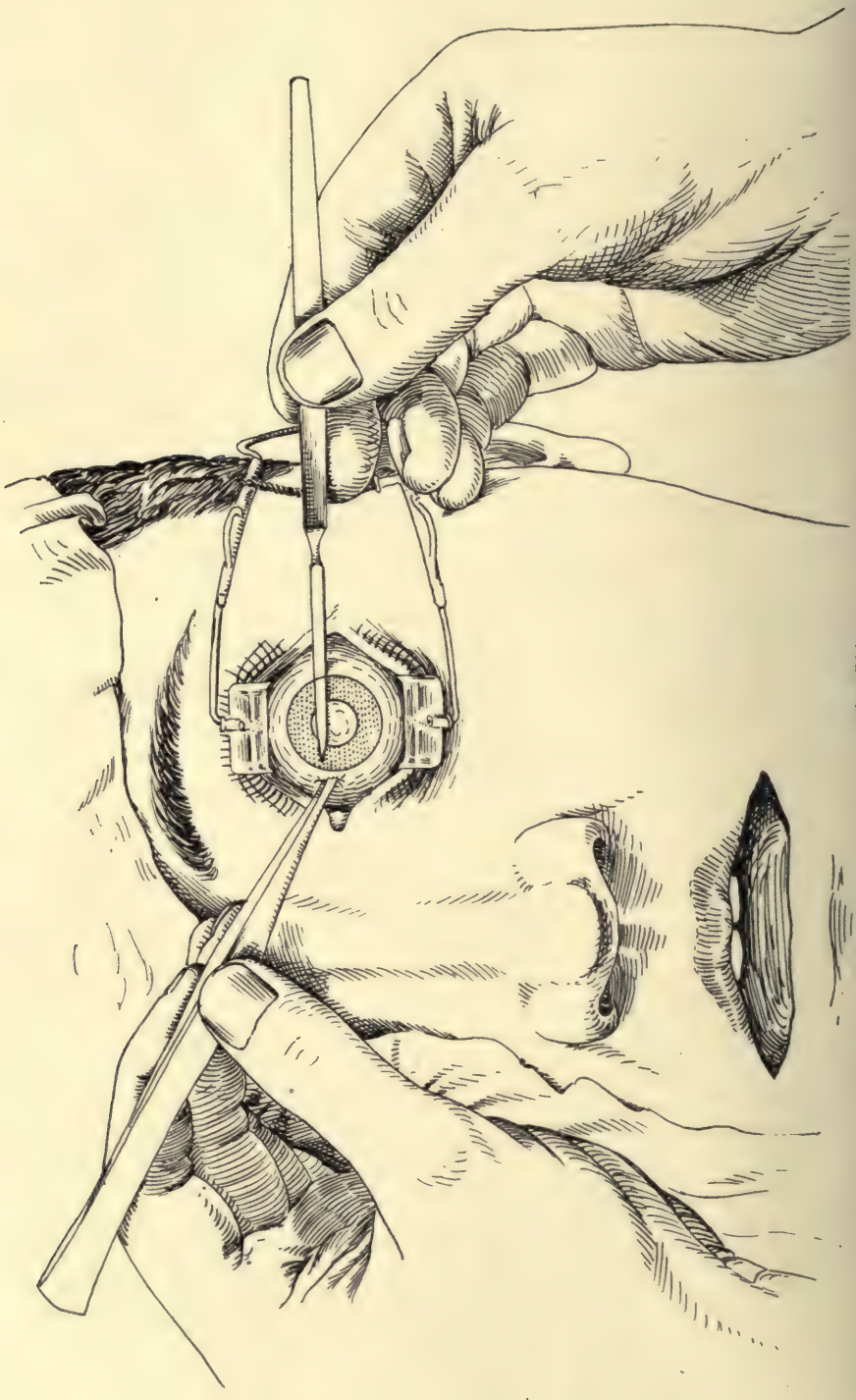


Fig. 501.
Incision with the Graefe knife (after Valude).

Whether the forceps or the hook is used, care should be taken to enter the instrument through the middle of the corneal incision for obvious reasons.

In a general way, and when there are no extensive adhesions, the artificial pupil tends to become larger than it was intended, and it will be the larger the more iris tissue is grasped with the forceps. It is well to keep this point in mind.

The iris having been drawn out through the corneal incision and pulled slightly forward, is cut off, generally with one, sometimes with two strokes of the scissors.

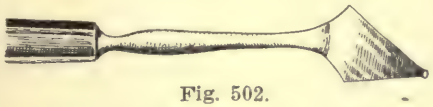


Fig. 502.
Blunt-pointed Lance Knife.

If it is intended that the artificial pupil should join with the preformed one, care must be taken that a piece of the sphincter edge is cut away. Otherwise the result will be two pupils.

Sometimes when there are no posterior synechiæ and the aqueous humor is allowed to flow out rather suddenly, a prolapse of the iris will take place when the knife having made the corneal incision is withdrawn. The iris can then be grasped outside and be cut off.

The scissors, of whatever form, should be held with the blades open near the iris forceps, so as to be able to cut this membrane as soon as it has been sufficiently drawn out to allow of an abscision of the

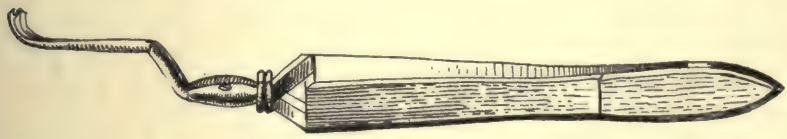


Fig. 503.
Mathieu Forceps.

desired extent. The size of the excised piece may be varied by the manner in which the scissors are held while cutting the iris off. When the blades of the scissors are held in a plane which is parallel to the corneal surface at the incision, a large piece of iris can be cut off. When, on the other hand, the blades are held at right angles to the line of incision, a small iridectomy which does not reach to the iris periphery, or even near it, or which, perhaps, only includes the sphincter edge, may be more easily accomplished especially by inclining the handles of the scissors slightly backwards towards the patient's face.

The scissors used for the abscision of the iris may be small and

of the older type, either straight or curved on the flat, or scissors of the type originated by de Wecker *(pince-ciseaux)*.

After the iris has been cut off, the limbs of the resulting coloboma may re-enter the anterior chamber by simply gliding back. Very frequently, however, some part is held between the wound lips, especially

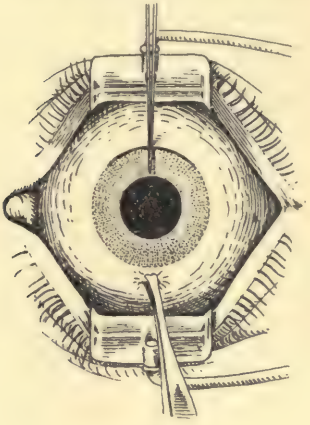


Fig. 504.
Introduction of the Iris Forceps.

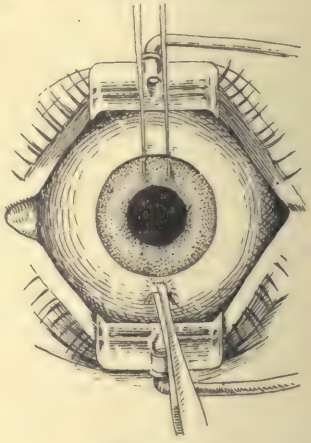


Fig. 505.
Opening the Iris Forceps.

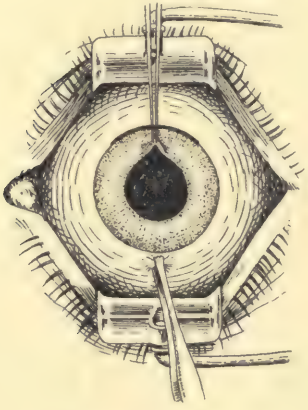


Fig. 506.
Grasping the Iris.

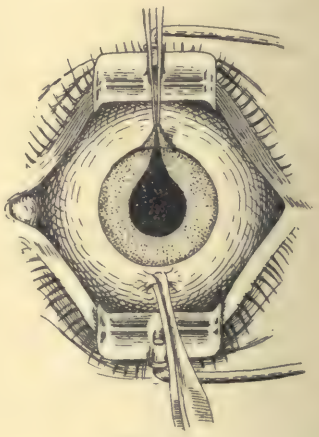


Fig. 507.
Drawing out the Iris Through the Corneal Incision (after Valude).

at the angles of the incision. Then the operator must accomplish the desired end by grasping the incarcerated portion with the iris forceps, drawing it out and cutting it off close to the cornea. The limbs of the coloboma may then withdraw into the anterior chamber, where they should appear of equal length.

In other cases it may be sufficient to enter the corneal incision with a thin narrow spatula and to gently push the margins of the coloboma back into the anterior chamber and into their proper position.

In these manipulations especial care must be taken not to wound the lens capsule or to tear the suspensory ligament.

Although after simple cataract extraction, in which the sphincter of the iris is not disturbed, gentle stroking of the corneal incision with a blunt instrument is very frequently sufficient to coax the iris back

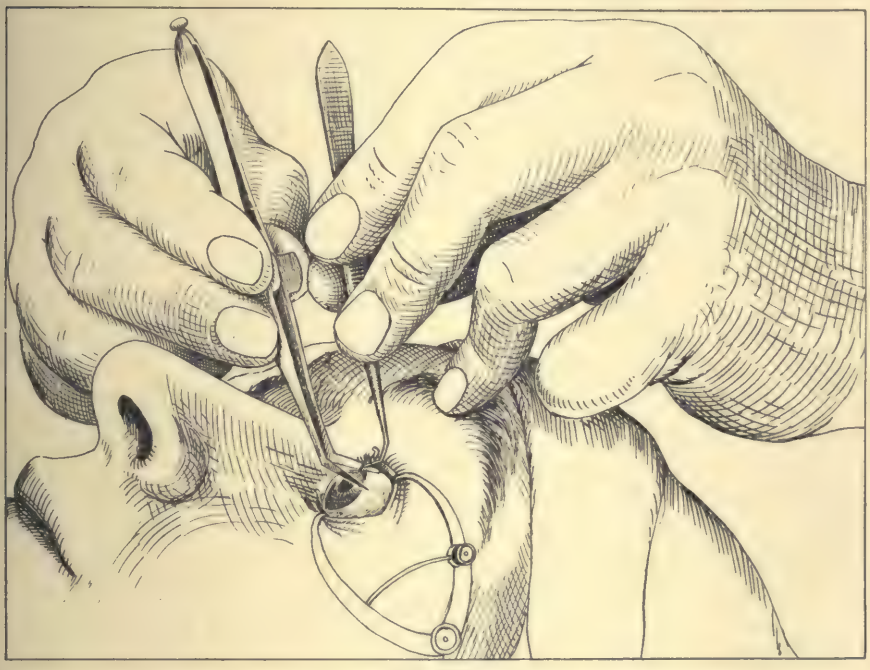


Fig. 508.
Cutting off the Iris with *Pince-ciseaux* (after Beard).

into the anterior chamber and into its proper position, this means seldom gives the desired effect after an iridectomy.

There are, however, cases in which it may be undesirable to cut the sphincter edge of the pupil, as, for instance, in making an artificial pupil which should be very small and be confined as much as possible to a certain transparent area. It seems that Pope[6] in 1871 was the first to devise such a procedure.

He made a corneal or scleral incision with a long and narrow

[6]Pope. Ueber Iridectomie ohne Durchschneidung des Sphincter pupillae. *Arch. f. A. and O.*, Vol. II, p. 192.

lance knife and then very carefully withdrew the knife in order to avoid any possibility of iris prolapse and any disturbance of the sphincter. Then a very fine, slightly curved iris forceps was introduced and the iris grasped with great care, again so as not to disturb the sphincter, gently pulled out of the incision and immediately snipped off with slightly curved scissors. By cutting the iris in such an operation at right angles to the radiating fibres the new pupil will assume a roundish shape, when cutting parallel with the radiating fibres a more elongated pupil will result. This operation was re-discovered and recommended by Salva.[7] Kuhnt[8] in 1885 devised an adjustable iris forceps with which he grasps a very small part of the iris between the sphincter edge and the periphery and then cuts it off with the scissors held in the direction of the radiating fibres.

Similar manipulations have been reported by other operators. However, they must be looked upon rather as suggestions as to how to act in certain cases and must be modified according to the needs of the case in hand.

Accidents During Iridectomy.

When the corneal incision is made with a lance-shaped knife and this *knife is entered into the corneal tissue,* in the direction of a largest circle, and the handle of the knife is depressed before the point of the knife can be seen in the anterior chamber, it may happen that instead of piercing the cornea the knife only enters the corneal tissue and, in being pushed on, splits the cornea in two, more or less parallel to its surface. The operator will become aware of such an occurrence when no aqueous humor escapes. He will then have to withdraw the knife and make another attempt. Such an accident is of a particularly grave nature when the transparent part of the cornea to be made use of is very small, since the scar resulting from such a splitting of the corneal lamellæ may defeat the object of the iridectomy.

Defects in the Corneal Incision.

The corneal incision may be made too small. This may be due to entering the knife in an oblique direction so that the inner wound is considerably smaller than the outer one, or to bad judgment in the selection of the width of the knife. If such an incision is too small for the ordinary iris forceps, it may be possible to use a Mathieu forceps or a blunt hook. If, however, the incision is too small even for the comfortable handling of these instruments, it is best to enlarge it with blunt-

---

[7]Salva. Iridectomie optique partielle. *Le Dauphiné medical,* Aug., 1900, p. 169.

[8]Kuhnt. Vorschlag einer Modification der Iridectomie zu optischen Zwecken. *Tagebl. der 58, Versammlung deutscher Naturforscher und Aerzte,* 1885, p. 497.

pointed scissors or a blunt-pointed knife. If the operator is aware of the condition, and he should be, before withdrawing the lance knife, he can enlarge the inner wound by lateral motions while withdrawing it.

Wounding the Iris, Lens and Suspensory Ligament.

If the point of the lance knife is pushed too far into the anterior chamber before the handle is depressed to give it a direction parallel to the iris, it may wound this membrane and even the crystalline lens, or, when the incision is very peripheral, the suspensory ligament. The iris, being thus engaged by the point of the knife, will be seen to be dragged along with it, it may even be torn from its ciliary attachment. If this should happen, the operator must try to disengage the knife by a slight backward movement, taking care not to allow the aqueous humor to escape.

If the point of the knife has pierced the iris and is pushed on still farther in the same direction, it must of necessity either wound the crystalline lens or cut the fibres of the suspensory ligament. The former injury causes the formation of a cataract; the latter may lead to a dislocation of the lens. Similar accidents may happen when the corneal incision is made with a von Graefe knife.

Too Rapid an Outflow of the Aqueous Humor.

The aqueous humor may be allowed to flow out too soon when the blade of the knife, while entering the anterior chamber, is slightly twisted so as to separate the wound lips. While there is less danger from such an occurrence when a lance knife is used, it may happen more frequently and be of more serious importance with a von Graefe knife, since the iris is apt to fall in front of the cutting edge of the knife and thus be cut through within the anterior chamber.

When, in pulling out the lance knife, or finishing the corneal section with a von Graefe knife, the aqueous humor is allowed to flow off suddenly, a number of accidents may happen. The most frequent is a prolapse of the iris. Some operators look upon this with so little disfavor that they actually try to produce such a prolapse, in order to escape entering the anterior chamber with the iris forceps and pulling the iris out. It is, however, best not to follow their example, since the occurrence of a prolapse in itself makes the judging of the exact size and position of the coloboma more difficult than when the iris is in its proper position.

Too sudden an outflow of the aqueous humor may, further, lead to a rupture of the suspensory ligament and consequent dislocation of the lens. In some cases such an accident may even lead to the loss of some of the vitreous body. In rarer cases a hemorrhage from the choroidal blood-vessels may take place.

Hemorrhage During Iridectomy.

Sometimes, when the blood-vessels of the iris are degenerated, bleeding from the iris tissue takes place as soon as the corneal section is completed, although the iris is not wounded. Such a hemorrhage may be small enough not to interfere with the further steps of the operation. The efforts to dislodge it and to empty the anterior chamber are not always successful, especially, if the blood coagulates quickly. Stroking the cornea with a spatula or similar smooth instrument, with slight pressure from the opposite side toward the corneal incision, may move the blood into the incision where it can be soaked up with sterile cotton and this often will accomplish the desired end. Any blood left behind in the anterior chamber will usually be absorbed within a few days. Bleeding from the cut edges of the iris occurs very rarely.

Iridodialysis During Iridectomy.

The iris may be torn off from its ciliary attachment by using too much force in grasping it, or by an untoward movement made by the patient. This accident was, perhaps, more frequently observed before local anesthetics were used. It even happened to some operators that the whole iris came away. The danger of such an occurrence is decidedly reduced in our day.

Firm Adhesion of the Uveal Pigment to the Anterior Lens Capsule After Iridectomy.

In cases of total posterior synechia the operator may find, after he has completed the iridectomy, that the uveal pigment has been left behind and fills the whole extent of the coloboma. This may happen even with a crater-shaped pupil. There is no remedy for this accident, which cannot be guarded against, except by the removal of the crystalline lens.

Healing After an Optical Iridectomy.

The healing after an optical iridectomy is, as a rule, uneventful. Very soon after the operation the wound lips are firmly enough glued together to allow the aqueous humor to fill the anterior chamber.

The firm histological union of the wound lips is only accomplished in about 18 days to 3 weeks (Alt*) but as a rule the adhesion of the wound lips is firm enough after a week to remove the bandage and to allow the use of the eye. When the corneal incision is very small, it is not even necessary to wait a whole week.

While at the present time with the necessary asepsis the healing after an optical iridectomy is as simple as has been stated, there is still a possibility of an irregular healing process.

*A. Alt. Beitraege zur Kenntniss der anat. Verhaeltnisse des Heilungsvorganges nach Iridectomie. *Arch. f. Aug. und Ohr.*, 1874.

Sometimes the wound of the corneal incision does not close promptly, so that for some days the aqueous humor leaks out and the anterior chamber is not re-established. This may be due to some foreign tissue lying between the wound lips or to a lack of vitality in the corneal tissue. In such cases it is usually best to remove what foreign tissue may lie between the wound lips (iris, conjunctiva, or, perhaps, lens capsule) and to apply a firm bandage which should not be disturbed for a number of days.

Sometimes an after-hemorrhage takes place a day or two following the operation and blood is found to lie in the anterior chamber. This occurrence usually calls for no interference since the blood, as a rule, is soon absorbed. Severe intraocular hemorrhage with consequent rupture of the wound probably never occurs after an optical iridectomy.

Sometimes a corneal incision which has been closed for a day or more is reopened by the patient, through sneezing, coughing, or some untoward movement of the hands, or by lying on the operated eye while sleeping. As a rule, such an accident does not amount to much and a secondary healing will readily take place. It may, however, amount to something more important, if, with the rupture of the corneal wound and the outflow of the aqueous humor, a portion of the iris next to the coloboma is forced into the wound canal or even outside of it. It will be best in such a case to remove the incarcerated or prolapsed part and thus give the corneal wound a new chance for more rapid closure.

There is, of course, a possibility of the corneal incision becoming infected. Yet even in pre-antiseptic times this hardly ever occurred after simple iridectomy. It is even more unlikely to happen nowadays when we operate with antiseptic precautions. Should it occur the results of the infection show, perhaps, on the second, usually on the third day after the operation by a swelling of the upper eyelid, some purulent discharge on the eye-lashes and some muco-purulent floccules in the conjunctival sac. The conjunctiva is somewhat edematous, there is ciliary injection and the wound lips appear yellowish-gray or yellow. The patient complains of pain. It is very rare that such an eye gets well without vigorous interference, and it is more often lost even in spite of that. The best remedy is a thorough cauterization of the wound lips, followed by the inspergation of xeroform, or some such antiseptic impalpable powder, and hot applications.

Secondary infections of the wound show their effects later and in a much milder manner. They usually lead to an iritis which must be treated in the customary way.

To prevent the corneal incision from becoming infected Ellett[9]

covered the whole cornea with conjunctiva. He dissected the conjunctiva from the sclerotic all around the cornea, as is done in enucleation, and freed it well to a distance of about one-half inch from the cornea. The conjunctiva was then pulled over the cornea and united by a horizontal row of stitches so as to cover the cornea completely. The stitches were removed on the fourth day. The conjunctiva slipped back into its normal position.

Further Indications for an Iridectomy Preparatory to Cataract Extraction.

While in optical iridectomy we have in the majority of cases to deal with an eye which has suffered from some disease of the iris—except in zonular cataract or subluxation of the lens,—an iridectomy performed at the same time with or preliminary to a cataract extraction is not usually hampered by any such adverse conditions. The rules for its performance are the same as given above. After Mooren's example a number of operators prefer to make the iridectomy some months before extracting the cataract, with the hope of insuring greater safety from the infection of the wound and iritis when the cataract is extracted. It is the custom with some operators to make such an iridectomy comparatively small, (pear-shaped) excising only such part of the pupillary margin of the iris as will insure an easy delivery of the cataract later on.

THERAPEUTIC IRIDECTOMY.

Iridectomy in Glaucoma.

This procedure having been treated in the chapter on glaucoma a description of it is omitted here.

Iridectomy in the Sequelæ of Iritis.

Iridectomy is sometimes performed in cases in which an iritis has produced an almost total posterior synechia. It is, also, recommended in chronic irido-choroiditis and in cases of relapsing iritis with which we sometimes meet. In all such it is best to wait until all signs of inflammation have passed before making the iridectomy, since if it is done too soon after, or even during the inflammatory attack the newly made artificial pupil usually closes up again and the result of the operation is nil. No iridectomy should be made on such an eye when the intraocular tension is very low.

Iridectomy in Corneal Ulceration.

After von Graefe had taught the beneficial influence of an iridec-

---

[9]E. C. Ellett. A New Method of Preventing Infection from the Conjunctiva after Operations Involving the Anterior Chamber. *Ophth. Record*, April, 1903, p. 160.

tomy in glaucoma, he tried this operation in a number of other eye affections, especially in diseases in which he expected a definite curative result from lowering even a normal intraocular tension for the time being. While the same result in these cases can be reached by tapping the anterior chamber, this little operation has to be repeated a number of times, since its effect, as far as the intraocular tension goes, is of very short duration. An iridectomy need not be repeated and exerts a more lasting influence.

The cases in which a therapeutic effect of an iridectomy is, perhaps, most evident, are those of ulceration of the cornea with the probability of a perforation of this membrane.

This operation was more frequently resorted to some decades ago than it seems to be at the present time. In fact, since the Saemisch incision, cauterization of the ulcer and attempts at serotherapy have come into prominence in the treatment of corneal ulcers, its beneficial action has been almost forgotten. The present writer has done it in a number of cases of ulcers and abscesses of the cornea which had resisted other treatment. The result has been most gratifying in all of these cases.

De Wecker[10] strongly recommended an iridectomy even in hypopyon-keratitis. Later on, in the work he published with the collaboration of Landolt[11] he was not quite as forcible in its recommendation and he finally abandoned it, like others, for the Saemisch incision. Bettremieux[12] in 1893, again recommended the execution of an iridectomy in hypopyon-keratitis as a superior remedy and insisted that the possibility of a later optic effect of this artificial pupil ought to be considered as secondary to its direct antiphlogistic and curative influence. His aim was to prevent a peripheral ulcer from involving the center of the cornea and, when possible, he made the iridectomy upwards.

TUMORS OF THE IRIS.

The Removal of Tumors of the Iris.

Tumors which appear in the iris may be either solid, semi-solid, or cystic. The solid tumors are usually sarcomatous. The semi-solid ones are vascular nævi or implantation cysts. The third form are cysts with a semi-transparent wall and serous contents. They are like the semi-solid tumors not malignant as to the life of the patient, but so to the welfare of the eye.

Whether it is best to remove an iris sarcoma by iridectomy or to

---

[10]De Wecker. *Traité des maladies des yeux*, 1887.

[11]L. De Wecker and E. Landolt. *Traité complét d'Ophtalmologie*, Vol. II, p. 172.

[12]P. Bettremieux. *Journal d' oculistique du Nord de la France*, Vol. V, No. 3, November, 1893.

enucleate an eye thus afflicted as soon as the diagnosis is made has been argued over again and again. It is clear that the removal of an iris sarcoma by iridectomy can be of value only when there is no doubt but that it can be really removed in toto. This is probably the case only when the tumor lies nearer to the pupillary edge of the iris than to its periphery, and when there are no symptoms pointing to a similar affection in other parts of the eye. Yet, even in the absence of such symptoms, the possibility of a microscopical sarcomatous deposit in another part, especially the ciliary body, cannot be denied.[13]

When it is decided to remove the tumor by an iridectomy, the corneal incision must be made so large that a large portion of the iris including the tumor can be grasped with the forceps, pulled out and cut off within healthy tissue.

Serous cysts of the iris when adherent to the posterior surface of the cornea offer great obstacles to their removal by iridectomy and when this is accomplished some remnants are almost certain to have been left behind.

When the anterior wall of such a cyst is not firmly attached to the cornea, Messmer[14] has recently performed and described a procedure which is rational and has proven successful in his case. After having dilated the pupil well, he punctured the cyst, by entering it through the cornea with a discision needle, and pushed into it parallel with the iris. By this tapping the volume of the cyst was considerably reduced. A second tapping reduced it still more and sufficiently so for Messmer to be able to remove it completely by an iridectomy.

IRIDOTOMY.

Iridotomy (or iritomy) is an operation in which the iris is incised for the production of an artificial pupil.

While the operation may be performed in eyes with a normal pupil and with a crystalline lens which is intact, but may be partly opaque, its main indication is the closure of the pupil by iritis or iridocyclitis after cataract extraction, or an injury.

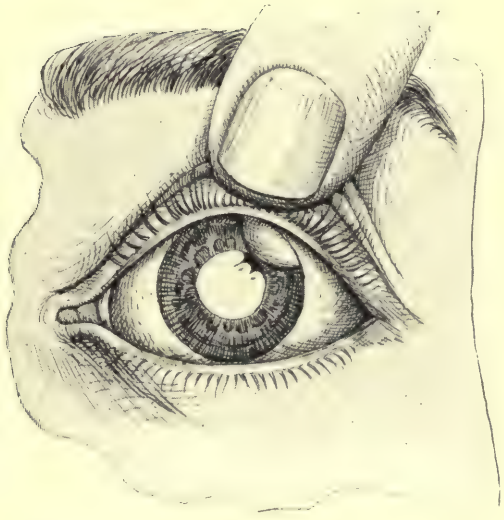
Historical Data.

Iridotomy was first performed by Cheselden in 1728, although

[13]Cf. M. Meyerhof. Weitere Untersuchungen an Sarcomen des Ciliarkoerpers und der Iris. *Klin. Mtsbl. f. Augenh.*, 1902. Lagrange. Traité des tumeurs de l'oeil, 1901. C. A. Veasy. Primary sarcoma of the iris. *Annals of Ophth.*, VI, p. 767. Casey Wood and Brown Pusey. Primary sarcoma of the iris. *Arch. of Ophth.*, 1902, p. 323. O. Fehr. Primaeres Sarkom der Iris. *Festschrift fuer Julius Hirschberg*, 1905. W. A. Shoemaker and A. Alt. Primary sarcoma of the iris, with report of a case of Leuco-Sarcoma of the iris and cysts of the ciliary body. *Am. Journ. of Ophth.*, Vol. XXVI, March, 1909, p. 65.

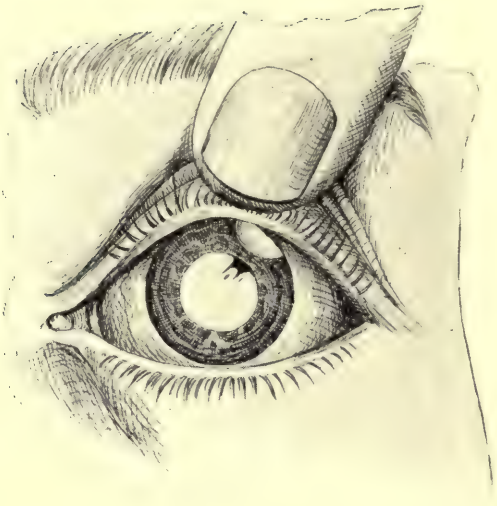
[14]C. Messmer. Personal communication.

Cyst of the Iris.

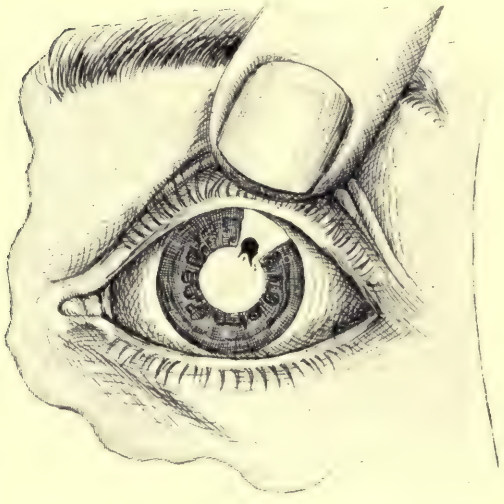


Cyst of the Iris After the First Tapping

PLATE VII.



Cyst of the Iris After the Second Tapping.



Cyst of the Iris After Iridectomy and Removal of the Tumor.

PLATE VIII.

Woolhouse in 1711 had conceived the idea of opening a closed pupil, however, without injury to the iris tissue.[15] Cheselden performed this operation with a sickle-shaped needle which he introduced through the sclerotic on the temporal side, and cut the iris from behind forward.[16] In 1756 G. Heuermann[17] made an iridotomy by entering a double-edged, lance-shaped knife through the cornea and incising the iris. This was a great step in advance of Cheselden's scleral method. Janin[18] was the first to replace the knife by scissors.

In 1792 Beer[19] described his method as an improvement of that of Cheselden. He used a double-edged lance knife with which, having entered through the cornea, he cut through the iris near the centre at right angles to the traction of the scar. His method was very similar to that of Heuermann. Maunoir[20] improved Janin's scissors method by using scissors with one sharp and one blunt pointed blade with which he made an incision in the iris through a previously made corneal incision, thus forming a V with its base towards the corneal wound. Sometimes he cut off the resulting iris flap.

Mackenzie[21] improved upon Maunoir's method by making the V-shaped incision across the stretched fibres and with the apex towards the corneal section.

Being prevented on account of illness from reporting in person, von Graefe sent a telegram to the Ophthalmological Society assembled at Heidelberg on September 5th, 1869, in which he urgently recommended the operation of iridotomy to be made with a sickle-shaped knife-needle or with a small myrtle-leaf-shaped, two-edged knife.

Bowman[22] made two corneal incisions opposite each other and made a V-shaped incision in the iris with the scissors through each one, so that the bases of the two triangles joined and formed a rhomboid. The tissues included in this rhomboid could then be withdrawn without dragging.

Iridotomy in Modern Times.

All of these different methods yielded some good results in the hands of their originators, yet, in spite of this it seems as if iridotomy was not as generally employed in suitable cases as it might have been.

---

[15]Hirschberg. Zur Geschichte der Pupillenbildung. *Ctrlbl. f. Augenh.*, XVI, 1892, p. 1.

[16]Cheselden. *Philosophical Transactions*, London, 1728, XXXV, p. 451.

[17]G. Heuermann. Abhandlung der vornehmsten chirurgischen Operationen. Kopenhagen and Leipzig, 1756, 11, p. 493.

[18]J. Janin. *Memoires et observations sur L'oeil*, Lyon, 1772, p. 191.

[19]G. J. Beer. *Lehre der Augenkrankheiten*, Wien., 1792, II, p. 12.

[20]J. P. Maunoir. *Mémoires sur l'organization de l'iris et l'operation de la pupille artificielle*, Paris, 1812.

[21]Mackenzie. *Diseases of the eye.* 3rd Ed., London, 1840, p. 746.

[22]Bowman. *Transactions of the 4th International Congress*, London, 1872, p. 179.

It has only come into its right, so to speak, since de Wecker[23] in 1873 published his paper on iridotomy.

De Wecker's Iridotomy.

De Wecker's work gave iridotomy a new era by an improvement in the instruments used. It was particularly his pince-ciseaux (forceps-scissors) which brought this about. He recommended a simple and a double iridotomy.

Simple Iridotomy.

Simple iridotomy was intended to be made use of in eyes with an intact lens and an open pupil. The corneal section was made with a lance knife with a stop by which De Wecker wanted to insure an opening 4 mm. in width, and no more. The corneal section was situated in the same meridian in which it was desired to cut the iris, but of course at right angles to it. The knife was then slowly withdrawn with the same care as when making such an incision for an iridectomy.

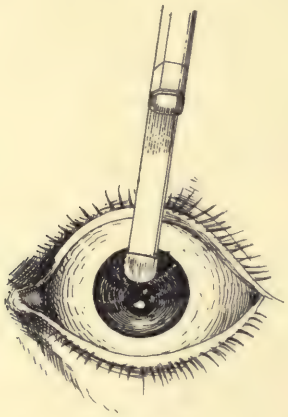


Fig. 509.
Beer's Iridotomy with a Broad Iris Knife. (After Mackenzie.)

For making a simple iridotomy de Wecker employed pince-ciseaux with blunt-pointed blades. Having completed the corneal section, these scissors were introduced with their blades closed and pushed forward towards the point on the pupillary edge of the iris where the incision was intended to be made. Then the blades being opened just sufficiently for the purpose, one of them was slipped in between iris and lens as far as desired, and by quickly closing the blades an incision was made in the iris, severing the sphincter pupillæ

[23]L. De Wecker. De L'Iridotomie. *Annales d'oculistique*, Sept.-Oct., 1873, p. 123, and *Annales d'oculistique*, V. LXXXII, 1879.

and as much of the iris tissue as was necessary in the case in hand. The scissors were then withdrawn and the eye bandaged.

Simple iridotomy has only a limited field of usefulness. It may be of value in cases of zonular cataract, of central opacity of the cornea, and in some cases of dislocation of the lens. Von Hasner[24] made an iridotomy (simple) a part of his cataract extractions.

The advantages of simple iridotomy are obvious. Yet, in practice, this operation is but seldom used on account of the danger of wounding the lens. To obviate this Schoeler[25] recommended to allow the iris to prolapse through the corneal section and to cut the sphincter edge of the iris with fine scissors outside the cornea. The iris is then replaced in its normal position by a spatula. Contrary to De Wecker's simple iridotomy, the scar in the cornea in Schoeler's method lies on the same side as the iris coloboma. The iris having been outside of the corneal wound, the danger of infection is greater.

Double Iridotomy.

Double iridotomy was recommend by De Wecker, especially in cases of closure of the pupil after removal or loss of the lens.

Fig. 510.
Straight and Angular Stop Keratomes.

De Wecker made the corneal section with a lance knife entered at the point of the periphery of the cornea toward which the contracting scar pulled the iris tissue. The extraction being made, as a rule, upwards, this meant that the new incision, also, lay upwards. The knife having entered the anterior chamber was pushed through the iris and whatever capsular or cyclitic tissue might be adherent to its posterior surface. The knife having been withdrawn, pince-ciseaux were introduced with one blade behind and one in front of the iris for the desired distance at one angle of the iris incision and the tissues were cut through. Then moving the scissors to the other angle of the iris incision the procedure was repeated. These three iris incisions included a flap, either with the base upward, when the incisions converged, or downward when the incisions diverged, which retracted and thus an artificial pupil was established.

Green[26] pointed out that it is best to place the incision so as to

---

[24]von Hasner. Neber Iridotomie. *Zeitschr. f. Heilk.*, 1881, p. 107.
[25]Schoeler. Zur opt. Pupillenbildung. *Berlin. Kl. Wechenschr.*, 1886, N-46, November 15.
[26]J. Green. Iridotomy by von Wecker's Method. *Trans. of the Am. Ophth. Society*, Vol. II, part III, 1876, p. 353.

divide, at right angles to their direction, such fibres of the iris as are seen to be in a state of abnormal tension. He made only one section as near the centre of the diaphragm as possible. The result is a horizontal pupil of oval shape.

Permanency of Result.

Although an iridotomy may have been made successfully, and the slow inflammatory process still going on in the eye may have been influenced very favorably by it, it does happen now and then that the newly made artificial pupil (partly or in toto) closes up again. This happens particularly when a hemorrhage into the wound and anterior chamber has taken place after the iridotomy. In such a case it may become necessary to repeat the operation; in some cases this has to be done several times, before a permanent opening is established. The operation must, however, not be repeated until the eye has become perfectly quiet. Impatience has taken away the last chance of vision from many such an eye.

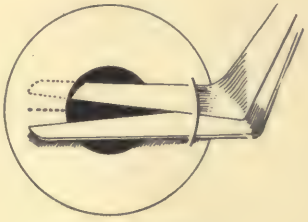


Fig. 511.
Simple Iridotomy.

Iridotomy with Knives or Knife Needles.

While De Wecker's iridotomy with the pince-ciseaux celebrated great triumphs, many operators objected to the necessity of a corneal incision and preferred the use of a knife or knife-needle. The incision of the iris with the lance knife often gives rise to a severe hemorrhage which obstructs the field of operation and makes the introduction of the pince-ciseaux very difficult. Sometimes vitreous will be lost, especially if it is abnormally fluid; the eye then becomes very soft and thus the operation is made very difficult, and the future of the eye is put into a less hopeful state. These evil accidents can be almost altogether avoided by the use of the knife or knife-needle.

In 1855 Hays[27] devised a knife-needle which, while having the general shape of Cheselden's knife, was much smaller. While it does not seem to have become generally known, it has been used in the United States ever since.

---

[27] I. Hays. *Am. Journ. of the Med. Sciences*, July, 1885, p. 82.

After von Graefe had again recommended the use of the sickle or a knife-needle, Gayet[28] in 1880 used a von Graefe cataract knife in performing iridotomy. He pierced the cornea and iris in the direction of a largest circle, that is, vertically to the corneal surface, then changed the direction to one parallel to the iris, pushed the knife behind the iris to the desired distance, then brought the point of the knife out again through the iris, and finished the incision in this membrane by withdrawing the knife with a sawing motion, without enlarging the corneal sections. Scherk[29] remarks that, aside from the other objections to performing iridotomy with scissors, which we have mentioned above, it seemed paradoxical to first relax a tense membrane (by the corneal section) in order to cut through it. He used a little knife similar to a discision needle with which he cut through the iris with a sawing motion without loss of aqueous humor.

Sichel[30] has used a similar procedure with a knife of his own device.

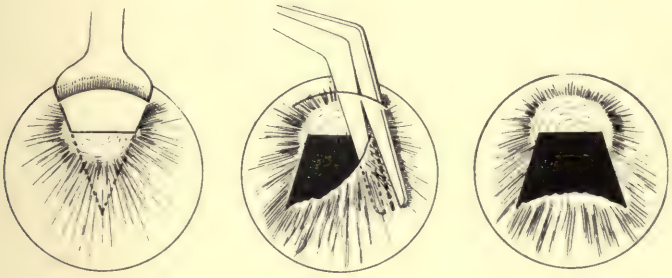


Fig. 512.

Double Iridotomy, de Wecker's Method. (After Valude).

Knapp's knife-needle, originally devised for capsulotomy, was and is, used by many operators for making an iridotomy.

In 1908 Ziegler[31] published his method of making a V-shaped iridotomy and the knife he had devised for this operation. This author says: "The character of the incision in the iris membrane is of vital importance. It should be a double incision. Our choice is a V-shaped incision which is undoubtedly the only one that will cut through all the iritic fibres in such a way as to give us the greatest retraction of the membrane. Absolutely no pressure should be made in cutting with the knife-needle," etc.

---

[28]Gayet. Nouveau procédé d'iridotomie. Congrés de Rheims. *Progrés méd*, N-35, 1880.

[29]Scherk. Iridotomie and Discission. *Kl. Mtsbl. f. Augenh.*, V. XXI, 1883, p. 315.

[30]Sichel. Zur. Iridotomie. Kl. Mtsbl. f. Augenh., V., XV., 1877, p. 273

[31]S. L. Ziegler. History of iridotomy. *Transactions of the Section on Ophthalmology of the A. M. A.*, 1908.

He describes his method of operating as follows:

"First Stage.—With the blade turned on the flat the knife-needle is entered at the corneo-scleral junction or through the upper part of the cornea, and passed completely across the anterior chamber to within 3 mms. of the apparent iris periphery. The knife is then turned edge downward, and carried 3 mms. to the left of the vertical plane.

Second Stage.—The point is now allowed to rest on the iris-membrane, and with a dart-like thrust the membrane is pierced. Then without making pressure on the tissue to be cut, the knife is drawn gently up and down

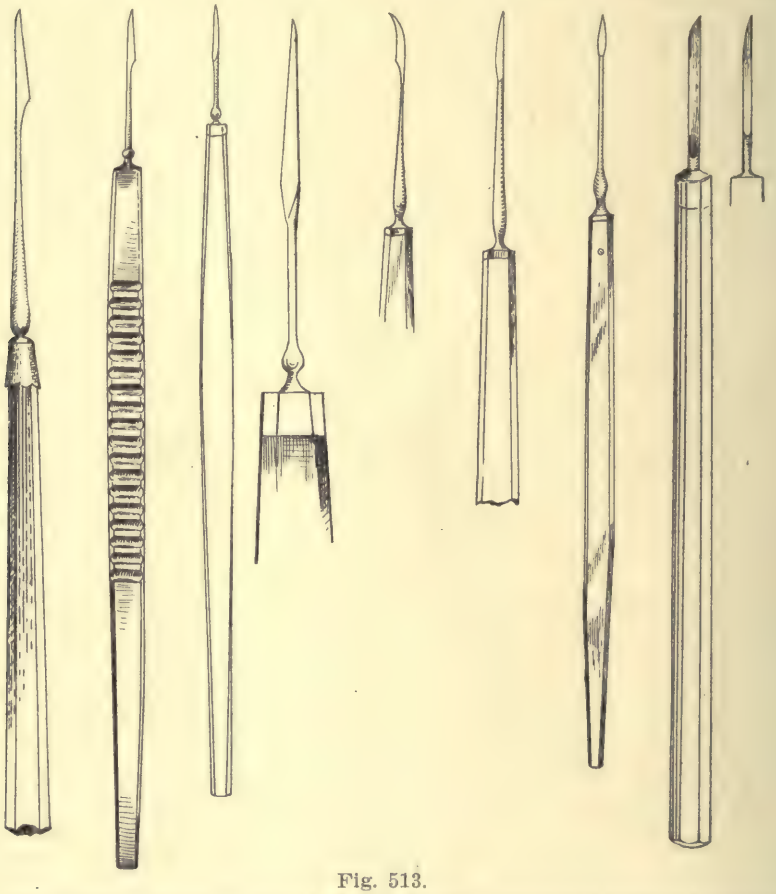


Fig. 513.

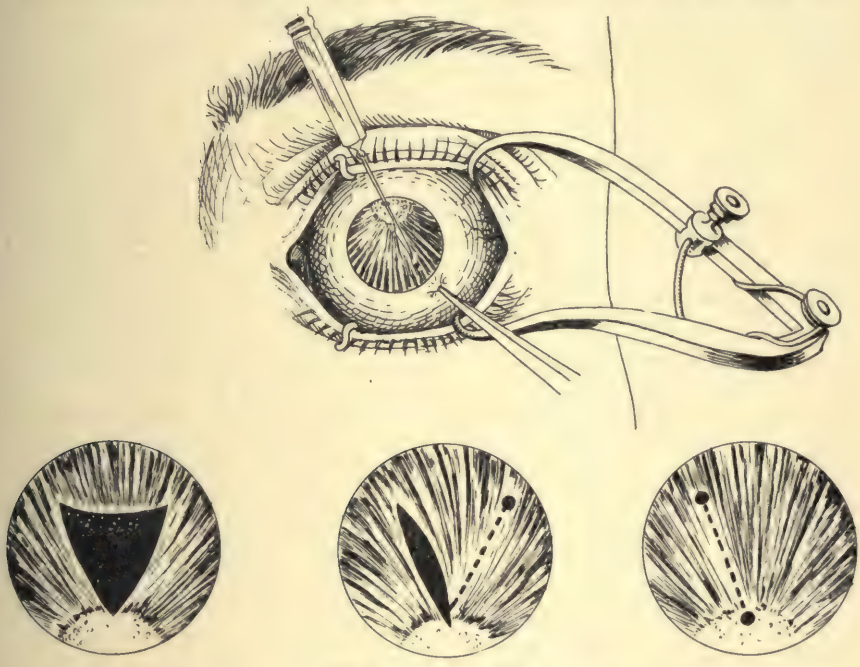
The Various Knife-needles and Iris Knives Recommended for Iridotomy (After Ziegler).

with a saw-like motion until the incision has been carried through the iris tissue from the point of the membrane puncture to just beneath the point of the corneal puncture. This movement is made wholly in a line with the axis of the knife, the shank passing to and fro through the corneal puncture, and the loss of any aqueous being carefully avoided in the manipulation.

Third Stage.—The pressure of the vitreous will now cause the edges of the incision to immediately bulge open into a long oval through which the knife-blade is raised upward, until above the iris-membrane, and then swung

across the anterior chamber to a corresponding point on the right of the vertical plane, which, owing to the disturbance in the relation of the parts made by the first cut, is now somewhat displaced, and the second puncture must be made at least 1 mm. farther over, that is, 4 mms. to the right of the vertical plane.

Fourth Stage.—With the knife point again resting on the membrane, a second puncture is made by the same quick thrust, and the incision rapidly carried forward by the sawing movement to meet the extremity of the first incision at the apex of the triangle, thus making a converging V-shaped cut. Care must be taken at this point that the pressure of the knife edge on the tissue shall be most gentle, and that the second incision shall terminate a trifle inside of the extremity of the first, in order that the last fibre may



Figs. 514 and 515.

Ziegler's V-shaped Iridotomy Knife-needle Entered Through the Cornea. First incision. Second incision. Result.

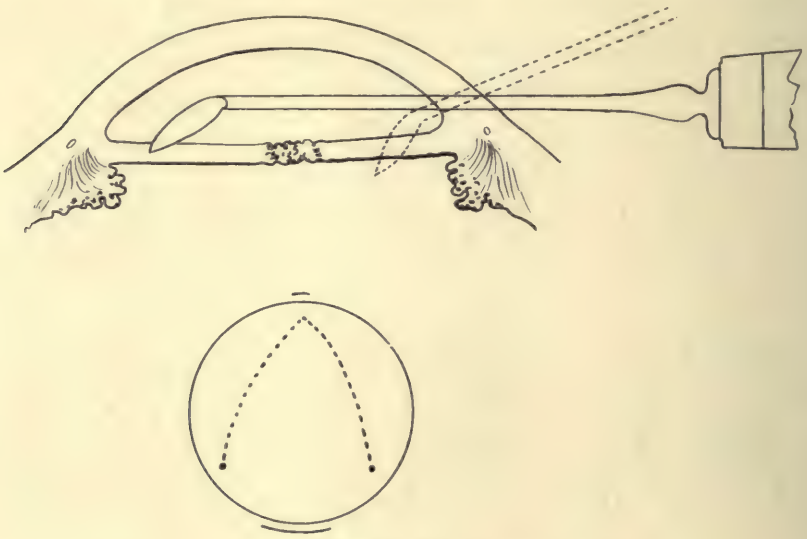
be severed and thus allow the apex of the flap to fall down behind the lower part of the iris-membrane. If the flap does not roll back of its own accord it may be pushed downward with the point of the knife. When the operation is completed the knife is again turned on the flat and quickly withdrawn."

In the same year, 1908, Jobson[32] proposed a new knife and method for iridotomy. His knife is similar to a cystotome with a large blade set at "a carefully calculated angle." This knife "makes its own incision in the globe and cuts with a minimum amount of dragging." The incisions made with this knife in the iris diaphragm are almost the same as those of Ziegler.

[32]G. B. Jobson. A new knife and method of iridotomy. *Ophth. Record*, Sept. 1908, p. 448.

General Considerations.

The history of iridotomy shows that the knife, at first employed for this operation by Cheselden, was replaced by Janin and Maunoir by scissors, which in turn were rejected by von Graefe and others and replaced by knife-needles, which are really only small knives. Again the scissors were introduced by De Wecker's ingenious work, only to give way again of late to the knife-needle. This very history shows that there are cases in which both instruments may work well, and that there are others for which the scissors, and again others for which the knife-needle, may best be employed. It would, therefore, seem injudicious to depend on the one instrument only, although it



Figs. 516 and 517.
Jobson's Iridotome and Iridotomy.

appears that a knife-needle of some shape, I should prefer Ziegler's, will, when used in this manner, answer the purpose in most cases.

The result of the operation as far the artificial pupil is concerned is most gratifying when a sufficiently large opening has been made in an iris the fibres of which have not yet lost all elasticity by atrophy. The conditions may be, however, and very often are, not so propitious. There may be remnants of the lens, the lens capsule and a cyclitic membrane, sometimes containing lime deposits, firmly attached to the posterior surface of the iris. In such cases it may well be doubted whether the knife-needle is the best instrument. They probably offer a better chance for the scissors, because the knife-needle may not be able to penetrate and cut such a mass of tissues matted together, and

may only succeed in tearing the iris periphery off from its insertion, which at least is not the object sought in this operation.

IRIDOECTOMY.

In 1879 De Wecker[33] described as a further useful operation to be made with his scissors which he called iridoëctomy. In this operation, instead of leaving the triangular flap to contract and thus keep open the newly made pupil, this flap is excised. The corneal incision is made as in iridotomy and followed, immediately after the aqueous humor has escaped, by the incision of the iris with the lance knife. The corneal incision is to be about 8 mms. long. Then the pince-ciseaux are introduced at one angle of the iris incision with one blade behind the iris, the other in front of it and pushed down and towards the centre of the diaphragm, as far as desired, and then the tissues

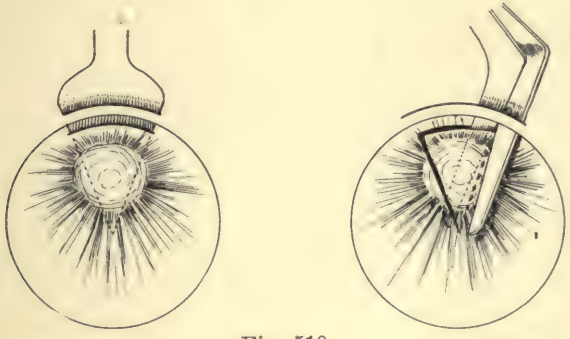


Fig. 518.
De Wecker's Iridoëctomy with a Lance Knife (after Valude).

are cut. After this a second incision is made from the other angle of the iris incision. In this manner a V-shaped triangular piece is cut out of the diaphragm which may be drawn out of the eye with the scissors when they are withdrawn, or afterwards with a pair of iris forceps.

In cases in which the iris diaphragm is very thick and unyielding it is better to use a von Graefe knife and make with it a peripheral corneal and iris flap incision. The point of the knife having penetrated into the anterior chamber, it is slightly pulled back to allow the aqueous humor to escape. Then the knife is thrust through the iris diaphragm and carried across to the point of counter-puncture and then the section, which divides iris and cornea at the same time, is finished. It is best, as a rule, to make this corneo-iridic section oppo-

[33] L. De Wecker. De la combinaison de l'iritomie avec l'excision et l'arrachement de l'iris, irido-ectomie et irido-dialysis. *Ann. d'oc.*, V. LXXLL, 1879, p. 137.

site the original cataract incision. Then the pince-ciseaux are entered in the manner described above and the triangular flap is cut out of the iris diaphragm and removed from the eye.

For certain cases in which the removal of the flap in the manner recommended by De Wecker seems impracticable Abadie[34] has devised a somewhat different procedure. Two corneal incisions are made at opposite sides of the same corneal diameter, each about 5 mms. in length, with lance knives. Then the pince-ciseaux, one blade of which has a sharp point, are entered with this blade through the one corneal section into the iris diaphragm, which is cut by two divergent incisions. Entering a hook or iris forceps through the opposite corneal incision, the iris flap is seized at its apex, drawn out and cut off. (Bourgeois made the two corneal incisions with a von Graefe knife by one thrust.)

Not satisfied with the results of these and similar operations, especially when the iris diaphragm is very tough and offers a great

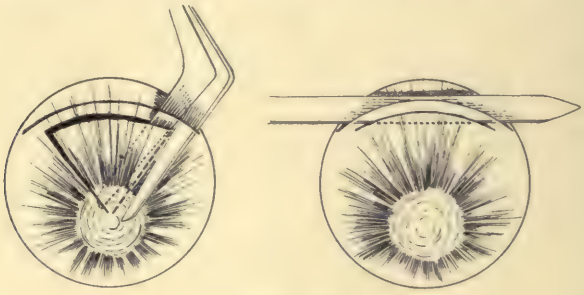


Fig. 519.

De Wecker's iridoëctomy with a von Graefe knife (after Valude).

resistance to knife and scissors, a number of authors have invented instruments with which to punch a piece out of the diaphragm, after an incision into the cornea and iris has been made.

Von Arlt devised and recommended such a punch. Having entered the anterior chamber with it, with closed beak, it is allowed to open far enough to get the iris diaphragm between the two blades. Then when closing the blades with firm pressure a piece of the diaphragm is punched out and withdrawn.

Krueger[35], Howe[36] and Culbertson[37] have also devised similar punching instruments.

---

[34]Abadie. De l'irido-ectomie, nouveau procédé operatoire. *Ann. d'ocul.*, **V. XCIX, 1888, p. 261.**

[35]Krueger. Ueber Iridotomie. *Vers. d. Ophth. Gesellsch. z. Heidelberg, Kl. Mtbl. f. Augenhl.*, 1874, p. 429.

[36]Howe. On a method of opening the closed pupil after operations for cataract. *Transact. Intern. med. Congress*, London, 1881, III., p. 129.

[37]H. Culbertson. The iricystome. *Am. Journ. of Ophth.*, Vol. I, p. 201.

General Considerations.

Iridoëctomy is in most cases a last resort, when conditions are desperate. It is clear, therefore, that not too much must be expected of this operation. It is, perhaps, not astonishing that in such cases hemorrhages are rarely met with, as the blood-vessels have become obliterated, but the manner in which these eyes stand such an operation without any inflammatory reaction is sometimes a surprise.

However, from the very condition in which these eyes are after having passed through severe inflammatory processes, we must not count on restoring a very valuable degree of vision to them, even if the newly made opening in the iris diaphragm remains open, as is usually the case.

IRIDODIALYSIS.

The object of the operation of iridodialysis is to open up a peripheral pupil in cases in which but little clear cornea is left. As in such cases the incision for making an iridectomy might cause a part

Fig. 520.
Abadie Iridoëctomy (after Beard).

of the clear space to be obliterated by the scar, such an operation may succeed in giving a better result.

The corneal incision is made with a lance knife in the opaque part thereof, usually near the centre. It is best to make it about 2 mms. from the clear part. The iris must not be wounded by the knife. Now a pair of iris forceps or a blunt hook is entered through the corneal incision and pushed forward to the ciliary insertion of the iris. The iris being firmly grasped with the forceps, or engaged with the hook, at its very periphery, is gently pulled away from its ciliary insertion. When this is successfully done the instruments may simply be withdrawn. In other cases it may be possible and advisable to pull the iris out through the corneal incision and cut it off. This would, of course, mean an iridoëctomy joined to the iridodialysis.

De Wecker, also, recommended to cut at once through cornea and iris as in iridectomy, and to make with his scissors two divergent incisions in the iris diaphragm to its very periphery. Thus a some-

what quadrangular iris flap is formed which is grasped with forceps and gently torn off from the ciliary insertion.

IRIDORHEXIS.

Iridorhexis was introduced by Desmarres[38] as a procedure when part of the posterior surface of the iris is firmly glued to the lens and the execution of an iridectomy is thereby impeded. In reality this operation does not differ from an ordinary iridectomy, except that the iris is with force torn loose from its adhesion to the lens. In order to do this with better success Desmarres' recommendation was to enter the closed iris forceps, through a rather large corneal section, with the concavity forwards and to shove it towards the adhesion so that the end of the forceps lies just over it. As large a piece of iris as possible is then seized not with the biting end, but between the

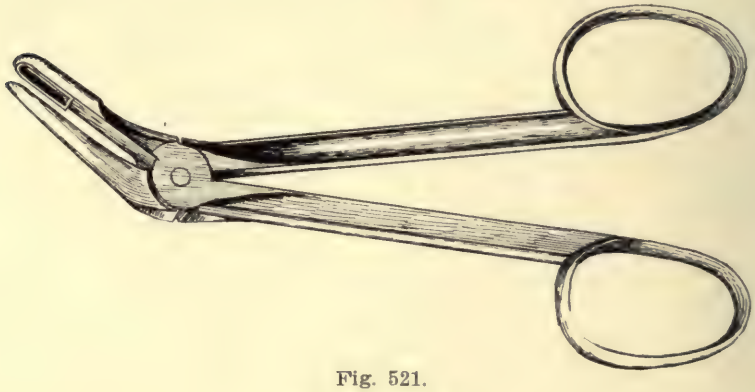


Fig. 521.
Arlt's Iris-punch.

branches of the forceps. This must include any subjacent exudative masses. With a rapid pull the iris is torn off from its adhesion, the forceps remaining within the anterior chamber. If the iris has come away from the lens, it may then be pulled out of the eye and be cut off.

IRIDENKLEISIS AND IRIDODESIS.

Iridenkleisis and iridodesis which have for object the dislocation of the pupil by fastening the iris permanently in a corneo-scleral wound, are operations which have been abandoned on account of the evil consequences which were attributed to them, especially cyclitis and possibly sympathetic inflammation. Whether these objections can be maintained when such an operation is made under aseptic precautions, the writer doubts. Their splendid effects, especially in zonular

[38]Desmarres. *Traité des maladies des yeux*, 1885, V. II, p. 542.

cataract, in dislocation of the lens, in keratoconus and in some leucomata of the cornea, can not possibly be denied.

Iridenkleisis was first introduced by Adams (1812) and Himly (1816). Later on Critchett[39] revised the operation. He made a small section at the corneal limbus corresponding to the site of the most transparent part. This opening was to be no larger than just to be able to grasp the iris through it with forceps. The iris, seized midway between its periphery and the pupillary edge, was slowly drawn out

Fig. 522.
Critchett's Iridenkleisis (after Valude).

and tied with a fine silk thread, the long ends of the thread being left hanging outside so as to prevent the slipping back of the iris. In this manner a small pupil could be placed in the most desirable and most useful position. After 48 hours the thread and iris tissue outside the wound fall off.

De Wecker and Stellwag in making this operation discarded the

[39]Critchett. *Trans. Ophth. Soc. of the United Kingdom*, 1892.

ligature and simply caused an artificial prolapse to become incarcerated in the corneal wound, and cut this prolapse off later on.

Bowman[40] by making two iridenkleises opposite each other, tried to procure a pupil forming a stenopeic slit in cases of keratoconus.

Iridenkleisis in Traumatic Iridodialysis

While, as said before, these operations have fallen into desuetude and are generally not accepted as safe procedures, occasions happen when an iridenkleisis may become necessary, as in cases of traumatic iridodialysis. The writer has several times performed this operation when iridodialysis was sufficiently large to worry the patient continually, not on account of the two pupils, but because of the partial immobility of the pupil and because the iris would dangle about with the movements of the eye. By causing the periphery of the iris to become incarcerated in a scleral incision, that is, making an iridenkleisis, the unsightliness of the eye and the subjective discomfort of the patient were removed.

Jameson[41] in cases of traumatic iridodialysis tried to bring about

Fig. 523.
Bowman's Double Iridenkleisis for Keratoconus (after Valude).

a union of the iris periphery with a freshened surface within the anterior chamber without incarceration of the iris in the corneal wound. Only the histological examination of such an eye will show whether he has succeeded in reaching his aim or not.

The first step in his operation is the introduction of 2 sutures 3 mms. back of the sclero-corneal margin into the anterior chamber where they are to pick up the torn iris periphery, less than 1 mm. from the torn edge. Then the needle is brought out through iris and cornea at the same time, and the needles are removed. Now a linear corneal incision is made in a straight line between the site of the two sutures, stopping at each end a short distance from where the needles were entered. Then a blunt hook being introduced, the parts of the threads which have pierced the iris and cornea are pulled back, out of the cornea and out of the eye. Each thread is then tied. Jameson says: "The sutures when tied bring the iris in contact with the inside of the

[40]Bowman. *Ophth. Hosp. Rep.*, 1860, p. 154.
[41]P. Ch. Jameson. *Arch. of Ophth.*, XXXVIII, 1904, p. 391.

linear incision and to the points of the primary perforation of the needles, but not between the lips of the incision." He uses horse-hair or silkworm gut for the sutures.

OPERATIONS FOR IRIDIC SYNECHIÆ, IRIDOLYSIS OR SPHINCTEROLYSIS. (CORELYSIS.)

The name *corelysis,* which it is better to replace by iridolysis, was given to an operation which has for its sole aim the freeing of the pupillary margin of the iris, when in consequence of iritis this has become adherent posteriorly to the anterior lens capsule, or by a traumatic or ulcerative perforation of the cornea anteriorly to this latter membrane.

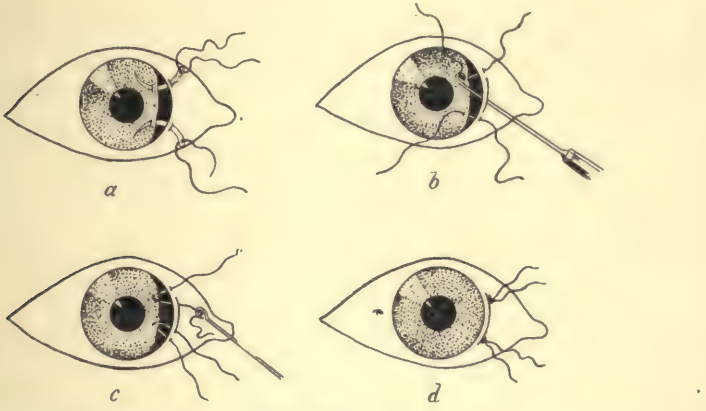


Fig. 524.

Jameson's Reattachment in Iridodialysis, Showing the Various Steps of the Operation.

General Considerations.

Such operations were formerly considered of great importance, since it was thought that the pulling on the iris or ciliary body due to such adhesions when the sphincter or the ciliary muscle were contracted, was the sole cause of pain and irritation, glaucomatous conditions, lack of accommodative power, and even of purulent inflammations, as are sometimes observed in such cases. In the light of better knowledge we must assume that at least the inflammatory symptoms are primarily due to the entrance into the iris tissue of some infectious germs, probably by way of the scar. When the scar is a solid one, this danger is but small.

On the other hand we know that the freeing of the adhering iris in eyes which are in a chronic state of irritation is often followed by considerable improvement.

Posterior Iridolysis.

Although Wenzel and Beer had already attempted posterior iridolysis with a sharp hook in cases in which the lens was cataractous, Streatfeild[42] was the first to perform this operation in eyes with a clear lens. In this he was soon followed by Weber.[43] These operators made a corneal incision near the centre of the cornea, or even at it, the choice of the position, however, being determined by the situation of the synechia or synechiæ. Streatfeild attempted not to let the aqueous humor run out. Then he entered the anterior chamber by means of a fine spatula, really a small knife, and tried to break the adhesion without injury to the lens capsule. Weber, on the other hand, purposely emptied the anterior chamber, then entered the eye with a small, flat hook which was introduced between the iris and lens. By very careful manipulation thus the posterior synechia was broken. Aside from the danger of wounding the lens, this operation very often proved useless either because it was impossible to sever the adherent tissue or the synechiæ would recur.

Passavant[44] did not attack the synechia directly, but after having made a small and oblique corneal incision in the meridian in which the synechia was situated, entered the eye with a forceps, grasped the iris as near the adhesion as possible, and carefully pulled it off from the lens.

Walker[45] having dilated the pupil at maximum entered the anterior chamber with a cutting needle at a point in the corneo-scleral junction opposite to the adhesion. The needle having been passed very carefully between the iris and lens capsule, the iris was engaged by it and lifted off the lens toward the cornea, and by lateral movements the adhesion was broken. The important point in this operation was the retention of the aqueous humor in the anterior chamber, even after the withdrawal of the needle. As far as the danger to the lens capsule is concerned, the sharp needle is, perhaps, more dangerous than either Streatfeild's spatula or Weber's flat hook.

In modern times these operations for posterior iridolysis are rarely even attempted, iridectomy having taken their place.

After cataract extraction with iridectomy when the lower pupillary margin had become adherent to the lens capsule, the writer has, in a few cases, instead of making a capsulotomy made a small peripheral incision downwards, entered a Tyrell's hook and gently loos-

---

[42]Streatfeild. *Royal Lond. Ophthalmic Hosp. Rep.*, 1857.

[43]Weber. Die instrumentelle unblutige Loslösung des Pupillarrandes von der Linsenkapsel (Corelysis). *Arch. f. Ophth.*, Vol. VII, 1860, p. 1, and Beitrag zur Operation der Corelysis, V. VIII, 1881, p. 354.

[44]Passavant. Briefliche Mittheilung (an A. v. Graefe), über eine Methode der Corelyse. *Arch. f. Ophth.*, XV, I, p. 260.

[45]G. E. Walker. 1885. Communication by N. Walker.

ened the pupillary margin from the lens capsule. In this manner a clear pupil was obtained and the insidious upward movement of the iris toward the corneal scar was obviated.

Anterior Iridolysis.

Anterior iridolysis has for its aim to free the iris which may have become adherent to the cornea after an operation, or an ulcerative or a traumatic perforation. Such an adhesion may have the shape of a small thread only, or be broader, or it may even concern a large portion of the iris, as is usual in adherent leucoma and in corneal or corneo-scleral staphyloma.

The operation, if successful, removes the attachment of the iris and has a beneficial influence on the bad condition due to it, and may open up a useful pupil.

Numerous operative measures have been devised by different operators and numerous different instruments have been recommended for their performance. Yet every case will have to be studied and handled on its own merits.

Bowman,[46] having made a small corneal incision, entered a blunt-pointed Weber's lachrymal knife and cut the iris off the corneal scar by pressing the edge of the knife against the latter.

Meyer[47] used a small sickle-shaped knife and cut the adhesion in the direction from the cornea toward the pupillary margin.

Kerschbaumer is reported by Schulek[48] to have used a narrow von Graefe knife for the same purpose.

Walker[49] also used a von Graefe cataract knife with which he entered the cornea peripherally at a point opposite to the synechia. By sweeping lateral movements he cut the adhesion without allowing the aqueous humor to escape, until the knife was withdrawn.

Lang[50] used two Knapp's knife-needles, one with a sharp point, the other with the point rounded off. With the pointed knife-needle he pierced the cornea at a point lying sufficiently far to the side of the corneal scar, so that the blunt knife, being entered after the quick withdrawal of the first one, could be easily introduced between the iris and cornea. With this second knife, the aqueous humor not having escaped, he could then easily cut the adhesion off. The chief difficulty seems to have been to find the small opening of the first knife-needle to enter the second one through it, though this defect in the

---

[46]Bowman. *Rep. of the 4th Internat. Congress*, London, 1873.
[47]E. Meyer. *Handbuch d. Augenhlk.*, Berlin, 1883, p. 108.
[48]Schulek. *Ungar. Beitr. z. Augenhlk.*, 1895.
[49]G. E. Walker. Communic. by A. N. Walker.
[50]Lang. The division of anterior synechtæ. *Ophth. Hosp. Rep.*, XII, 1889, p. 356.

technique is somewhat lessened by making it over or in front of a plainly visible scleral vessel.

Others have used de Wecker's pince-ciseaux successfully to cut off such anterior synechiæ.

For more complex cases with partial corneal staphyloma Abadie[51] has devised a procedure which he called *staphylotomy*. The aim of this operation is to free the iris from the base of the staphyloma. The operation is performed with a von Graefe knife which enters the cornea, in case of a corneo-scleral staphyloma, near the scar tissue, and is passed through what anterior chamber may be left, between cornea and iris. Now, with a sawing movement, the iris is cut off from the base of the staphyloma parallel to the cornea. Near the corneo-scleral margin the knife is withdrawn without cutting through the corneo-scleral tissue. In an ideal case of this kind the previously tense iris is cut off from the base of the staphyloma and retracts at once.

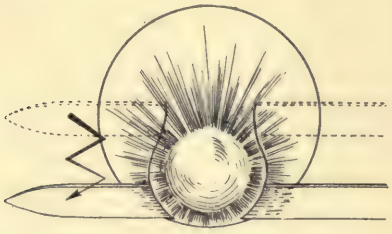


Fig. 525.
Abadie's Staphylotomy.

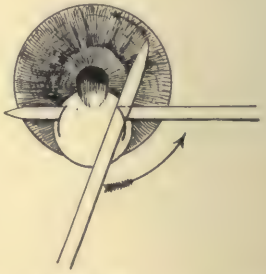


Fig. 526.
Schulek's Sphincterolysis Anterior.

In cases in which no anterior chamber exists, Abadie goes at once with the knife through both cornea and iris and passes through the posterior chamber, making a counter-puncture symmetrical to the point of entrance on the other side of the staphyloma. Then, with a sawing motion, the iris is cut off the base of the staphyloma by cutting parallel with the cornea to the corneo-scleral margin.

Schulek,[52] using a knife-needle with a convex edge, entered the cornea with the knife on the flat, so as to cut one side of the adhesion by turning the cutting edge toward the cornea. He then passed the knife through the pupil behind the iris and cut the other side of the adhesion.

Another method, called by Schulek sphincterolysis anterior, aims at freeing the pupillary edge of the iris alone. He entered a narrow

[51]Abadie. Traitément du staphyloma partial et progressif. Staphylotomie. *Annal. d'ocul.*, V. XCIII, 1885, p. 5.
[52]Schulek. *Ungar. Beitr. z. Augenhlk.*, 1885.

von Graefe knife on the flat within the scar tissue and tangentially to one limb of the adherent sphincter edge. Then he turned the handle around an angle of 100 to 120 degrees and in this manner placed the edge of the knife in such a position that both limbs of the anterior synechia could be cut at the same time by making a counter-puncture and cutting, with a sawing motion, toward the corneo-scleral margin. The flap could be left unfinished by withdrawing the knife, or completed, as the case might demand.

TEMPORARY RESECTION OF THE SCAR. SACHS' OPERATION.

The operations just described are particularly concerned with an adherent scar, due to prolapse of the iris at some time in the history of the case, which is beginning to give way to the intraocular pressure, or has already done so (staphyloma). They become necessary especially if the pupillary area is covered totally or nearly so by the corneal or corneo-scleral scar. For such cases Meller[53] says that he now prefers a temporary resection of the cicatrix with the aid of a trephine, a method first recommended by Sachs. With the trephine placed obliquely on the cornea a flap is cut out, which is then lifted by an assistant to enable the operator to enter the anterior chamber, draw out the iris carefully on all sides and cut it off. In order to succeed, the base of the flap must be so situated that the iris can be most easily grasped, this is usually toward the pupil. The iris having been freed, the corneal flap is returned to its position and the eye bandaged. Care must be taken not to injure the lens, when it is not already cataractous. If the lens capsule is adherent to the scar an injury cannot be avoided.

[53]Meller. *Ophthalmic Surgery* (Transl. by W. L. Pyle), 1908, p. 219.

CHAPTER VII.

THE OPERATIVE TREATMENT OF GLAUCOMA.

By WM. CAMPBELL POSEY, M. D., Philadelphia, Pa.

Definition of Glaucoma—Varieties—Pathogenesis of the Disease—The Retention and Other Theories—Secondary Glaucoma and Its Causes—Synechiæ—Wounds of the Lens—Serous Cyclitis—Intraocular Tumors—Hemorrhagic Glaucoma—Congenital Glaucoma—Buphthalmos—The Treatment of Glaucoma—Operations on the Anterior Half of the Eye—Paracentesis of the Cornea—Operations that Effect a Communication Between the Anterior Chamber and the Subconjunctival Spaces—Anterior Sclerotomy—Complications and Indications—Modifications of the Operation—Iridosclerotomy—Combined Sclerotomy—Incision of the Iris Angle—Operations that Effect a Communication Between the Anterior Chamber and Vitreous—Sclero-cyclo iridic Puncture—Sclerotomia Anterio Posterior—Iridectomy—Technique of the Operation in Glaucoma—Complications and Accidents During Iridectomy—After-Treatment—Theories to Account for the Efficacy of Iridectomy—Prognosis After Iridectomy—The Operation of Most Value in the Acute and Subacute Varieties—Miotics Versus Operative Measures in Chronic Glaucoma—Treatment of Hemorrhagic Glaucoma, Buphthalmus and Secondary Glaucoma—Modifications of Iridectomy — Sclero-Iridectomy — Irido-Sclerotomy—Ciliarotomy—Filtering Cicatrix—Iris Incarceration Methods—Wedge Isolation Operation—Lagrange Operation—Holth's Cystoid Cicatrix Operation—The Use of the Scleral Trephine in Glaucoma—Verhoeff's Sclerostome—Drainage Through the Choroid and Perichoroidal Space—Hyposcleral Cyclotomy—Sclero-Choriotomy—Cylodialysis—Posterior Sclerotomy—T-shaped Sclerotomy—Indications for Posterior Sclerotomy—Influence of the Sympathetic on Ocular Tension—Technique of Sympathectomy—Statistics—Removal of the Ciliary Ganglion—Avulsion of the Infratrochlear Nerve.

Definition of the Term.

Glaucoma is the term applied in a broad sense to that condition of the eye as a consequence of whatever cause the intraocular pressure has become pathologically increased.

When the symptoms of increased intraocular tension arise in an eye which is apparently otherwise healthy, the glaucoma is termed *primary;* when, however, the eyeball hardens as a result of some preceding intraocular disease it is designated as *secondary* glaucoma.

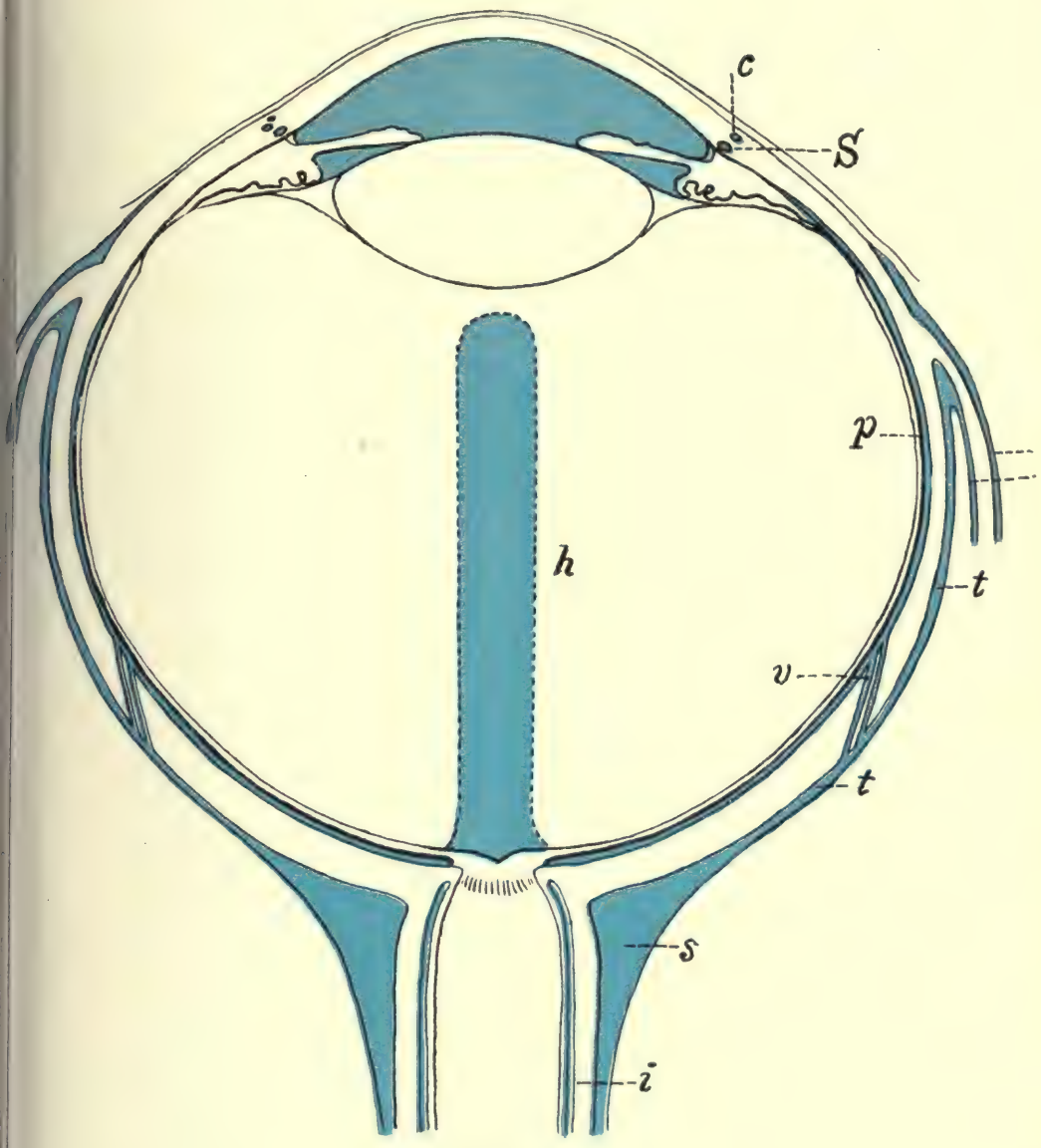


PLATE IX

Lymph Passages of the Eye (Schematic).

S. Schlemm's canal. c. Anterior ciliary veins. h. Hyaloid canal. p. Perichoroidal space, which communicates by means of the venæ vorticosæ, v, with Tenon's space, t.t. s. Supravaginal space. i. Intervaginal space. ee. Continuation of Tenon's capsule upon the tendon of the ocular muscles (lateral invagination). (Fuchs).

Primary glaucoma varies greatly in its manner of onset, and occurs either in an acute fulminating form, *acute congestive glaucoma,* or as *subacute* or *chronic non-congestive glaucoma,* the symptoms in the subacute variety being remittent and less severe than in the acute form,

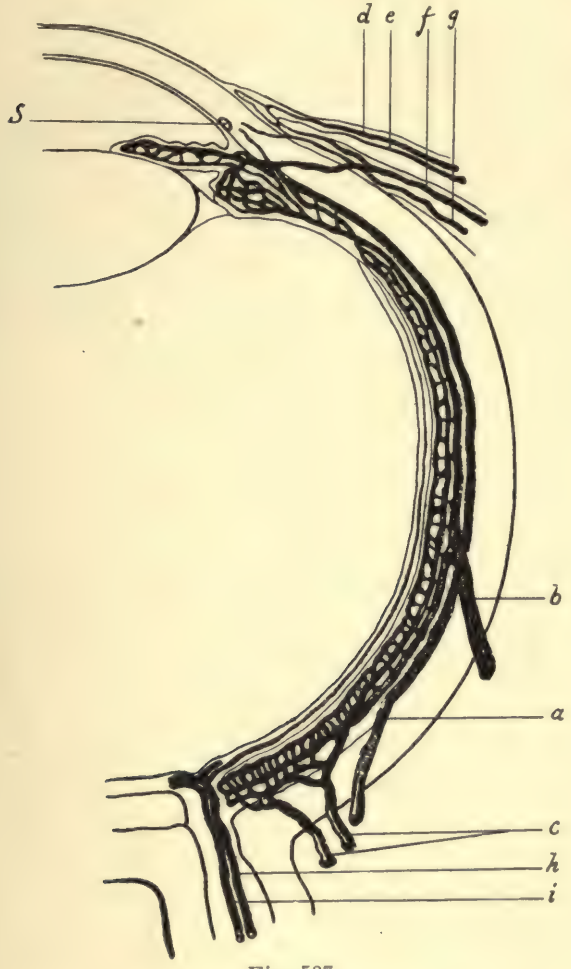


Fig. 527.

Blood Vessels of Eye-ball.

a. Long posterior ciliary artery
b. Vena vorticosa
c. Short posterior ciliary arteries
d. Conjunctival artery
e. Conjunctival vein
f. Anterior ciliary artery
g. Anterior ciliary vein
h. Central artery of retina
i. Central vein of retina
s. Canal of Schlemm

while in the chronic form the disease may terminate in blindness without inflammatory signs. All three types, however, merge into one

another and the disease may appear in one eye under one form and under a different type in the other.

It is beyond the scope of this chapter to dwell long either upon the maintenance of the normal intraocular pressure or the causes and consequences of an excess of pressure, but it will be necessary to consider each of these points very briefly in order that the principles underlying the operations which have been devised for the relief of glaucoma may be clearly understood.

As Fuchs[1] aptly puts it, "The intraocular pressure is determined by the relation between the internal capacity and the elasticity of the envelopes of the eyeball, on the one hand, and the amount of its contents on the other. If the latter factor increases or the former factors diminish, the pressure is elevated."

There are three kinds of fluid within the eyeball, i. e., blood in the blood vessels, lymph within the lymph spaces of the uveal tract and the perivascular lymph channels, and the intraocular fluid in the aqueous and vitreous chambers.

The blood vessels within the eye are contained chiefly in the uvea, and anastomose freely with one another, thereby favoring the compensation of circulatory disturbances, the anterior ciliary veins in glaucoma, for example, becoming distended with the outflow of venous blood from the eye when the venæ vorticosæ are blocked as a consequence of the increased pressure. The amount of blood within the eye is subject to alterations in the blood-vessels and is also influenced by changes in the shape of the iris and ciliary body and by pressure from without, as for example, by the action of surrounding muscles.

The lymph, which is derived from the blood vessels and dependent in amount on the blood pressure, is contained in two main lymph passages, the anterior and posterior.

The intraocular fluid is secreted by the epithelium covering the ciliary body, the folds of this structure overlying a dense plexus of blood-vessels, providing a comparatively large epithelial surface to facilitate the process of secretion. As Collins[2] has demonstrated, there are moreover on the pigmented layer numerous little tubular recesses, presumably glands, which are concerned to some extent in the elaboration of secretion. It has been found experimentally by Adamük, Jesner and Niesnamoff, that the amount of fluid secreted is proportional to the difference in pressure within the blood vessels and that within the eye, i. e., outside the vessels.[3]

---

[1]Fuchs. *Text Book of Ophthalmology*, 2nd English Edition, page 413.
[2]Collins. *Diseases of the Eye, Nose, Throat and Ear.* Posey and Wright, p. 525.
[3]Parsons. *The Pathology of the Eye*, Vol. III, p. 967.

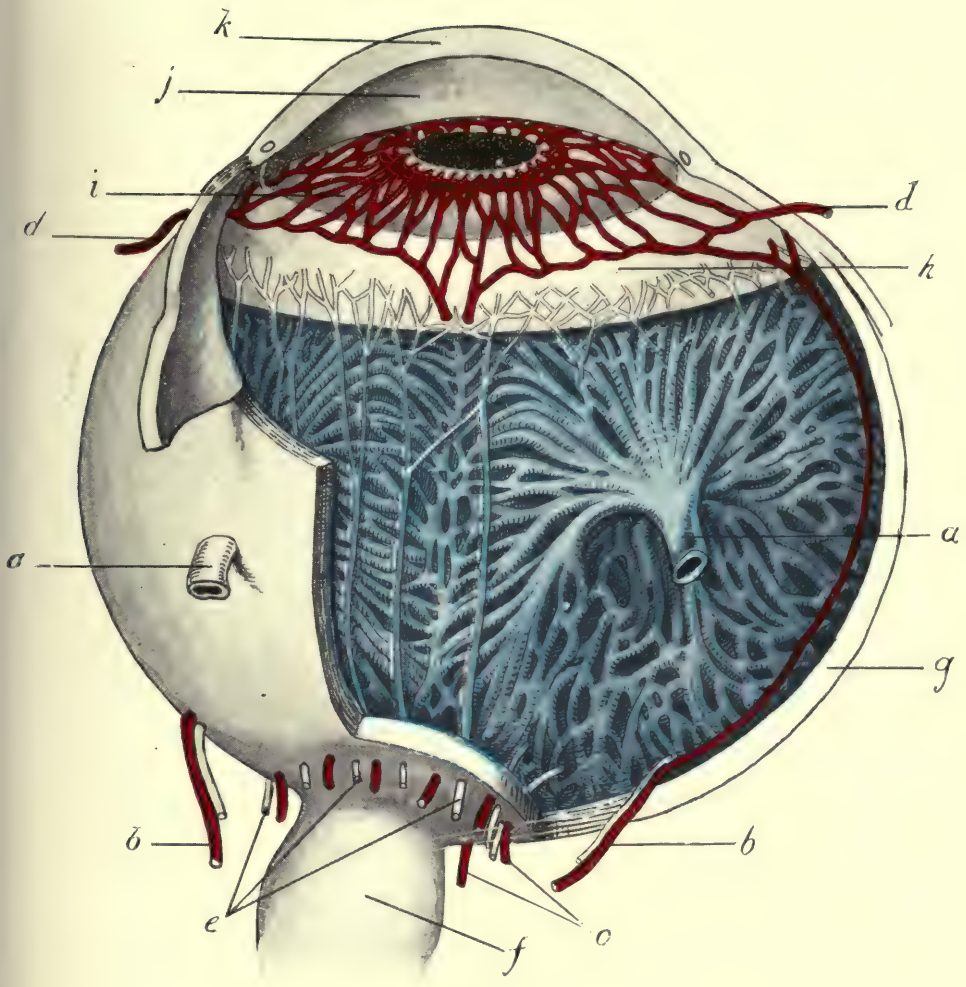


PLATE X

Peripheral Nerves and Blood-Vessels of the Eyeball.

a. Great vorticose vein.
a′ Great vorticose vein passing through Sclera.
b.b. Long posterior ciliary arteries.
c. Short posterior clliary arteries.
d. Anterior ciliary arteries.
e. Ciliary berves.
f. Optic nerve
g. Sclerotic.
h. Ciliary zone.
i. Iris.
j. Anterior Chamber.
k. Cornea.

The greater part of the intraocular fluid passes directly forward between the iris and lens into the anterior chamber. It then traverses this chamber and finds its main avenue of exit in the angle formed by the junction of the iris and cornea, whence it passes through the spaces of Fontana in the ligamentum pectinatum, into the canal of Schlemm by a process of diffusion and filtration, and finally, leaves the eye by the anterior ciliary veins. According to Nuel[4] a part of the fluid is absorbed and eliminated by the iris, entering the openings on the anterior surface of this membrane, which are situated for the most part near its ciliary and pupillary margins, and thence finding its way into the veins of the iris by filtering through the walls. (See Fig. .) A small amount of the fluid also flows backward through the vitreous, and escapes through the posterior lymph passages by way of the perivascular lymph channels in the optic nerve. Priestley Smith believes it is doubtful if there is any continuous flow from the vitreous into the anterior chamber, but in all events the intraocular fluid readily permeates through the anterior hyaloid membrane and suspensory ligament, and in health any excess of fluid in the vitreous escapes through the filtration angle in the anterior chamber.

The *maintenance of the intraocular pressure* depends upon the proper secretion and excretion of the fluids within the eye. In the normal eye the relation between the amount of ocular fluids which are secreted by the blood-vessels, and the quantity of fluid which leaves the eye through the lymph passages is always about the same, and a normal pressure is maintained. When this relationship is disturbed and the intraocular pressure rises above the normal, glaucoma is present.

The mechanism or influence which operates as the regulating power in maintaining the relationship between normal secretion and excretion has not as yet been definitely determined and there is still lacking an adequate explanation to account for the cause of the primary rise in the intraocular tension, and the essential factor in the production of glaucoma is still unknown.

Pathogenesis of Glaucoma.

Generally speaking, there are two chief theories which have been advanced to account for the rise in pressure, one the hypersecretion theory, which contends that it is due to an increase in secretion, as a consequence of some form of nervous irritation, the other, the so-called retention theory, that it results from a mechanical obstruction which is offered to the outflow of fluids from the eye. While the evidence

[4]Nuel. Des voies D'Elimination Des Liquides Intra-oculaires Hors de la Chamber Antérieure et au Fond de L'oeil (Nerf optique, etc.) *Archiv. D'Ophtalm.*, April, 1900, p. 161.

seems quite conclusive as far as primary glaucoma is concerned, that the increased tension results in a disturbance offered to the outflow of the fluids, rather than in the increased secretion of fluids within the eye, nevertheless, the retention theory cannot explain all cases of glaucoma and there are undoubtedly other factors present in very many instances.

DeWecker, Galezowski and Schweigger were the chief exponents of the hypersecretion theory originally advanced by von Graefe and Donders, which made all forms of glaucoma dependent upon the condition of the sympathetic nervous system. This theory, however, has been controverted by the repeated observations which have been made both clinically and experimentally that no appreciable change in the intraocular tension may follow considerable alteration in the sympathetic system.

In a recent paper, Lagrange[5] holds to the hypersecretion theory, and believes it to be the primary cause of glaucoma, the hypersecretion being due to a nervous disorder (excitation of the sympathetic), and to an alteration in the blood or the vessels (sclerosis). He believes that one of these factors may suffice, but when they act together, the effect is so much the greater. While hypersecretion is the principal cause, Lagrange, however, asserts that there is speedily added another factor of capital importance, namely, the obliteration of the excretory channels, thereby harmonizing the theory of hypersecretion with the so-called retention theory.

The retention theory is based upon the fact that according to the researches of Knies and Weber, and Priestley Smith and Collins, every eye the seat of primary glaucoma is predisposed to the disease as a consequence of certain peculiarities in its build. This predisposition depends, as Fuchs puts it, on insufficient spatial relations, which may either affect the eye as a whole or particularly the region of the anterior and posterior chambers. Priestley Smith has proven, in a manner that is conclusive to most ophthalmologists, that a want of space between the crystalline lens and the parts which surround it is a frequent predisposing cause of primary glaucoma. This observation was based on the following facts, that[6] a, the size of the lens increases throughout life, b, the liability to primary glaucoma increases throughout life, c, the liability to primary glaucoma is greatest in eyes of exceptionally small size, d, a disproportion between the size of the lens and the size of the globe can be demonstrated in some eyes blinded by primary glaucoma.

As long as the circumlental space is patulous, the eye is free from glaucoma, but as soon as this space is contracted the lymph is secreted from the ciliary body, becomes dammed up in the vitreous, which increases in volume, and pushes the lens and iris forward, reducing still more the depth of the anterior chamber. After a time if the increased intraocular tension is maintained, the root of the iris becomes agglutinated to the cornea at the angle of the chamber, and the chief avenue of escape of the intraocular fluids is permanently blocked.

The retention theory has recently received considerable support from several able papers by Henderson.[7] This writer has departed somewhat from former views regarding the manner of closure of the filtration spaces, and asserts that his researches demonstrate that the primary difficulty resides in an obstruction and closure of the pectinate ligament. He claims that this structure, the *cribriform ligament*, as he proposes to rename it, is nothing more than "an open and non-sclerosed part of the sclera, and as such consists of longitudinal and circular fibres arranged crossways as a warp and a woof, so as to form an open network on the inner side of Schlemm's canal, extending anteriorly from the inner lamellæ of the cornea

[5]Lagrange. De la Cicatrice Filtrante Dans La Cure Du Glaucome. *Archiv. d'ophtalm.*, Feb., 1908, p. 65.

[6]P. Smith. *Glaucoma*, p. 84.

[7]Henderson. *British Medical Journal*, Nov. 2, 1907; also *Trans. Ophth. Soc., U. K.*, Vol. XXVIII, 1908.

(at a point opposite the termination of Descemet's membrane), to be lost posteriorly, the outer portion in the sclera, the inner in the connective stroma of the ciliary muscle." He believes that as a process of advancing years the scleral portion of the ligament becomes sclerosed, so that it approaches in structure that of the surrounding sclera. As a consequence of this sclerosis, the meshes of the filtrate network impede the outflow of the aqueous humor, and the predisposition given to glaucoma. If there be added to this a vaso-motor change, acute glaucoma results.

There has been much evidence of late to prove the influence of arteriosclerosis in producing glaucoma, and while Rohmer, who has collaborated the following theories that glaucoma may be produced by arterial sclerosis,—(1) by obstructing the outflow of the intraocular fluids in the veins (Fuchs, Schnabel, Birnbacher, Czermak); (2) by altering the composition of the ocular fluids (Stölting); (3) by lowering of the arterial blood pressure (Sulzer, Zimmerman; (4) by increasing the blood pressure (Bajardi and Joseph); (5) by edema of the vitreous (Terson), thinks that these theories are premature; nevertheless, he is convinced[8] that there is no doubt that this vascular disorder may have a place in the pathogenesis of the disease.

Coats[9] contends that in some way glaucoma may be the result of thrombosis of the central retinal vein with its consequent hemorrhagic retinitis, and has offered the following explanation of the occurrence of the increased tension in this class of cases. "In consequence of the severe congestion and hemorrhagic suffusion of the retina, the character of the lymph circulating in the vitreous is altered; it becomes more abundant and also more colloidal and is therefore less easily drained at the angle of the anterior chamber. The rise in tension is, therefore, in some sense analogous to that which occurs in serous iritis."

From a recent study of six eyeballs exhibiting obstruction of the central vein, Verhoeff[10] has proved conclusively that this lesion may early give rise to acute glaucoma.

Phlebitis affecting the vortex veins in their course through the sclera has been described as a cause of primary glaucoma, but Priestley Smith asserts that while an obstruction of these main trunks would, no doubt, congest the whole of the uveal tract and might prove a potent cause of glaucoma, the evidence of its occurrence as a primary lesion in glaucoma is extremely scanty and he is rather inclined to believe that it is more likely to be a consequence rather than a cause of glaucoma.

Finally, Schmidt-Rimpler and Kuschel[11] maintain that a loss or disturbance of elasticity of the supporting tissues of the eyeball is often a predisposing factor in glaucoma.

When the filtration angle of an eye predisposed to glaucoma has become very narrow, the employment of any of the drugs used to dilate the pupil may induce an attack of glaucoma by the thickening of the iris-base which accompanies the dilatation of the pupil.

In concluding these brief remarks on the pathogenesis of glaucoma, the writer believes that he cannot convey a more succinct and accurate account than by quoting Priestley Smith's own words. "The causes of primary glaucoma then, are various and complex, and are not yet completely known; but they are alike in this: that they all lend to compression of the filtration angle. With that compression the

---

[8]Rohmer. L'artério-sclérose Oculaire. *Archiv. d'ophtalm., May*, 1906, p. 317.

[9]Coats. Intraocular Vascular Disease. *The Ophthalmoscope*, Nov., 1906, p. 605. On the Pathology of Chorio-Vaginal (Posterior Vortex) Veins. *The Ophthalmic Review*, April, 1906, p. 99. Further Cases of Thrombosis of the Central Vein. *Royal Lond. Hosp. Reports*, Vol. XVI, pt. 4, p. 516.

[10]Verhoeff. *Archiv. f. Ophthal.*, Jan., 1907.

[11]Kuschel. Die senile Sklerose des hydrostatischen Regulierungsapparates des Auges als Hauptursache der glaukomatösen Disposition. *Zeitschr. f. Augenheilk.*, March, 1908, p. 193.

actual glaucoma-process begins. The escape of fluid is retarded and the intraocular pressure rises; the increasing pressure hinders the flow of blood through the choroidal veins, and augments the swelling of the ciliary processes; this, in its turn, increases the compression of the filtration angle. The fluid which still exudes from the turgid ciliary body is albuminous and less diffusible than the normal secretion; it tends to accumulate behind the lens, and this latter, being

Fig. 528.

The Angle of the Anterior Chamber in a healthy Eye, showing the Canal of Schlemm, the ligamentum pectinatum, and lymphatic crypts at the periphery of the iris. (After Collins, in Posey and Wright.)

pressed forward, intensifies the mischief. Thus cause and effect react upon each other in a vicious circle.

"In acute glaucoma we see the vascular element at its maximum, in chronic glaucoma at its minimum; in the subacute and intermittent forms it seems to ebb and flow under various influences which aid or embarrass the circulation in the uveal tract. The vascular element finds its complement and auxiliary—more marked in some cases, less

marked in others—in the predisposing structural condition of the eye."

Secondary Glaucoma.

As has already been stated, the term secondary glaucoma is applied to an eye when it has become hardened as a result of some preceding intraocular disease. It may arise, therefore, in an eye in no way previously disposed to glaucoma, as is the case in primary glaucoma. According to the nature of the intraocular disease which evokes the glaucomatous symptoms, the manifestations of secondary glaucoma vary, the increase in tension being accompanied at times by inflammatory symptoms similar to those of primary inflammatory glaucoma, while in other instances it may be diagnosed merely by a

Fig. 529.

The Angle of the Anterior Chamber in a Case of primary Glaucoma, showing closure of the filtration area at the periphery of the cornea, by apposition with it of the root of the iris. (After Collins, in Posey and Wright.)

perceptible increase in hardness of the eye ball and by the progressive loss of sight, which results from the pressure upon the optic nerve.

Before enumerating the various intraocular diseases which may evoke secondary glaucoma, it may be stated that microscopic examination has determined that the increased tension is occasioned in all instances by changes which obstruct in one way or another the escape of fluid from the eye. In most cases this has been found to consist in a closure of the filtration angle of the anterior chamber, either by actual agglutination of the base of the iris with the cornea or by a blocking of the angle with morbid exudates.

The *affections of the eye which may lead to increased tension* are as follows:

Posterior Synechiæ of Iris. Following the agglutination of the pupillary edge of the iris to the lens capsule in its entire circumference, a condition known as *annular posterior synechiæ,* the aqueous humor is prevented from entering the anterior chamber and accumulates between the iris and lens, bowing the former forward and giving rise to what is known as iris bombé. After a time the root of the iris becomes adherent to the base of the cornea, and the eye hardens as a consequence of a blocking up of the spaces of Fontana. (See Fig. 530.)

In cases of total posterior synechia, the term applied to a complete adherence of the iris to the capsule of the lens, the secretion of the ciliary body is unable to percolate between the iris and lens, and, accumulating in the vitreous chamber, raises the pressure there, and

Fig. 530.

Glaucoma Secondary to Iritis and the Formation of Annular Posterior Synechia. Fluid accumulating in the posterior chamber has bowed the iris forward into contact with the back of the cornea. (After Collins, in Posey and Wright.)

forces forward the lens and iris. The angle of the chamber becomes closed by the apposition of the root of the iris with the cornea, and glaucoma is established.

Anterior Synechiæ of Iris. After perforation of the cornea, and the incarceration of the iris in the cicatrix, even the partial apposition of the iris against the posterior surface of the cornea may occasion sufficient blocking of the filtration angle to induce glaucoma. When a more extensive incarceration of the iris leads to staphyloma, secondary glaucoma also follows, the increase in the prominence of the staphyloma tending to draw the iris still farther forward and increase the glaucomatous process.

Anterior Synechiæ of Lens Capsule or Hyaloid Membrane of Vitreous. The filtration angle may also be blocked in consequence of an adhesion of the capsule of the lens or of the hyaloid membrane of the vitreous after operations or injuries which have opened the anterior chamber. Treacher Collins[12] has shown that glaucoma may be produced in this way even when iridectomy has been performed, the filtration area opposite the coloboma being blocked by a small piece of the root of the iris, which was left, or by the most anterior of the ciliary process. (See Fig. 531.)

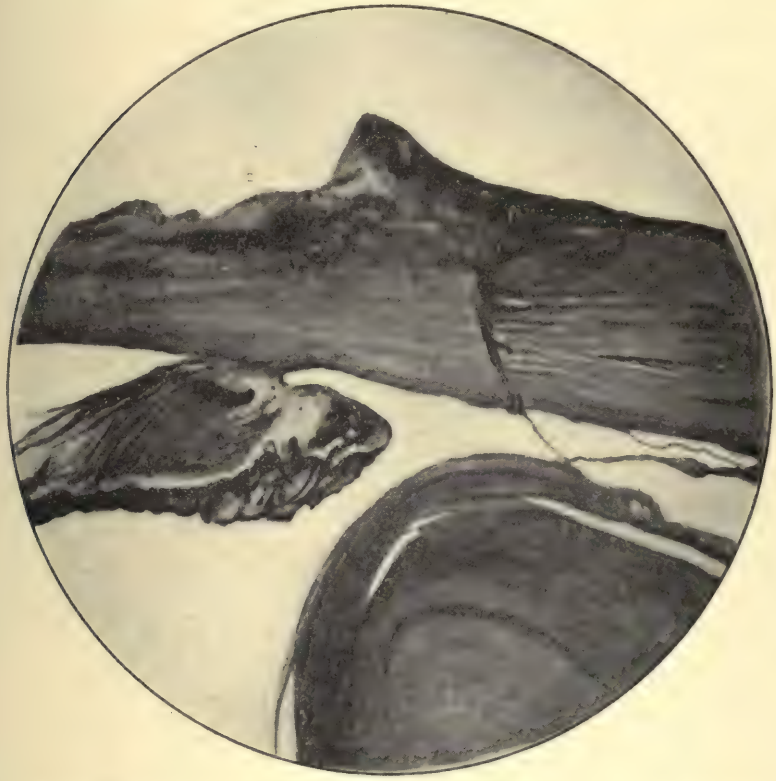


Fig. 531.

Section through the Center of the Coloboma in an Eye which had had an Iridectomy Performed for Glaucoma of two months' standing. The tension was relieved by the operation. The eye was excised five weeks later for ulceration of the cornea. The iris has been removed up to the ciliary body and the angle of the anterior chamber thereby opened up. (After Collins, in Posey and Wright.

Wounds and Luxation of the Lens. Swelling of the lens after injury or operation may give rise to increased tension either by the

[12]Collins. Glaucoma after extraction of cataract. *Trans. Oph. Soc., U. K.*, Vol. X, 1890, p. 108.

swollen lens pressing forward the iris and closing the filtration angle (See Fig. 532) or by the pectinate ligament becoming blocked by particles of undissolved lens matter getting entangled in its meshes. It is also probable, as Collins[13] has pointed out, that the aqueous humor becomes loaded with the colloid substance globulin of which the lens is mainly composed and as a consequence escapes with greater difficulty from the eye than is the case under normal conditions.

All forms of luxation of the lens may occasion glaucoma, the displaced lens either obstructing the angle by pressure upon the root of the iris, or by blocking the pupil, interfering with the passage of fluid through it.

Fig. 532.

Glaucoma Secondary to Traumatic Dislocation of the Lens. The displaced lens has pressed forward the iris into contact with the back of the cornea. The iris and ciliary body where they were in apposition to the lens are much atrophied. In preparation of the specimen an obvious slight alteration in the position of the lens has taken place. (After Collins, in Posey and Wright.)

Serous Cyclitis. As Collins[14] has tersely expressed it there are three factors which combine to give rise to increased tension in serous cyclitis: (1) excess of secretion; (2) albuminous character of the aqueous humor; (3) accumulation of inflammatory cells in the spaces of Fontana. The obstruction to the circulation of the fluid being

[13]Collins. *Diseases of the Eye, etc. Posey and Wright*, p. 549.
[14]Collins. *Diseases of the Eye. Posey and Wright*, p. 550.

primarily at the outlets from the anterior chamber, and the albuminous character of the fluids making it difficult for it to filter through the anterior hyaloid membrane into the vitreous, an accumulation takes place in the anterior chamber which becomes deepened, the lens and iris being depressed backward. (See Fig. 533.)

Intraocular Tumors. As a consequence of the pressure exerted upon the vitreous by the presence of retinal and choroidal tumors, this structure becomes so compressed that fluid is less easily pressed out

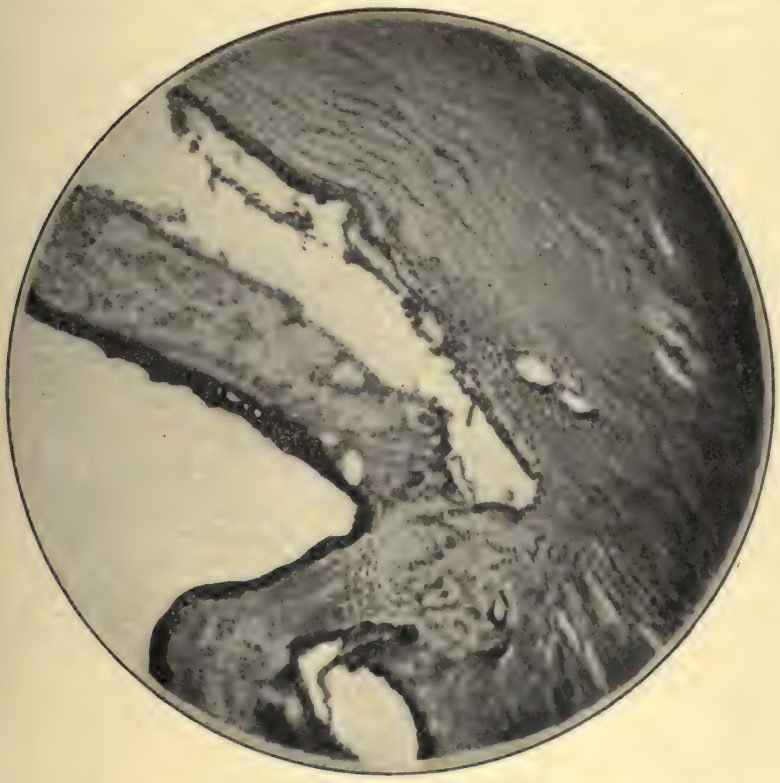


Fig. 533.

Angle of the Anterior Chamber in an Eye which had Glaucoma Secondary to Serous Iridocyclitis. It shows wide separation of the root of the iris from the back of the cornea, with an accumulation of inflammatory cells on the inner surface of Descemet's membrane and in the mesh of the ligamentum pectinatum. (After Collins, in Posey and Wright.)

of it. The tension in the vitreous chamber then becomes greater than in the anterior chamber and the lens and iris are pushed forward until the filtration angle becomes permanently blocked.

When the growth is adjacent to the iris, the angle of the chamber

may be blocked by direct pressure of the mass of the tumor against the base of the iris.

Secondary glaucoma may arise in eyes *the seat of detached retina,* without the presence of a tumor, the angle of the anterior chamber being blocked in much the same way as is the case of an intraocular growth by some hemorrhage or serous effusion into the sub-retinal space forcing forward the lens and iris.

Thrombosis of the Retinal Veins. Hemorrhagic Glaucoma. In elderly people, as a consequence of changes in the retinal vessels or from disturbances in the general circulation, hemorrhages into the retina sometimes excite an attack of glaucoma. Microscopic examination has shown that a thrombosis of the retinal veins is usually the sublying factor in this condition. It is probable that the venous engorgement and serous effusion into the retina, together with the serous effusion into the vitreous, which follows the thrombosis, occurring in an eye which is structurally predisposed to glaucoma, causes an increase of pressure in the vitreous, which becomes the exciting cause of the glaucomatous attack. The iris and lens are pushed forward and the angle of the chamber becomes obliterated.

Congenital Glaucoma, or Buphthalmos. As Collins[15] has shown, a congenital malformation in the chamber for exit of fluid from the eye is the probable cause of the increase of tension in these cases. To quote his own words, "In some a congenital adhesion, or, rather, failure in separation of the periphery of the iris and back of the cornea, has been found, in some, strands of tissue about the angle of the anterior chamber, suggestive of adhesions which had become stretched and broken down by the collection of fluid in the anterior chamber, which forced backward the iris and forward the cornea. Such a breaking down of congenital adhesions which at one time existed, explains the cases in which spontaneous relief of tension occurs. In other cases the canal of Schlemm was stated to be congenitally absent." (See Fig. 534.)

THE TREATMENT OF GLAUCOMA.

As glaucoma consists in an increase in the intraocular pressure, the chief indication in the treatment of this condition calls for the reduction of the tension of the eye. This may be accomplished either by operation or by the use of miotics. Since this work treats chiefly of the operations used in ophthalmology, the descriptions which follow are of the various operations which have been planned from time to time for the relief of glaucoma, and mention of the employment of

[15]Collins. *Diseases of the Eye, etc. Posey and Wright,* p. 553.

miotics and of other accessory remedial measures will be made only in so far as they bear upon the surgical conduct of the disease.

Largely by reason of the fact that the cause of glaucoma is still in doubt and of the very considerable number of theories which have been advanced from time to time to account for it, the operations which have been proposed for its cure are numerous, each being devised by its originator either with a view to relieving what he considered to be the most potent factor in maintaining the increased

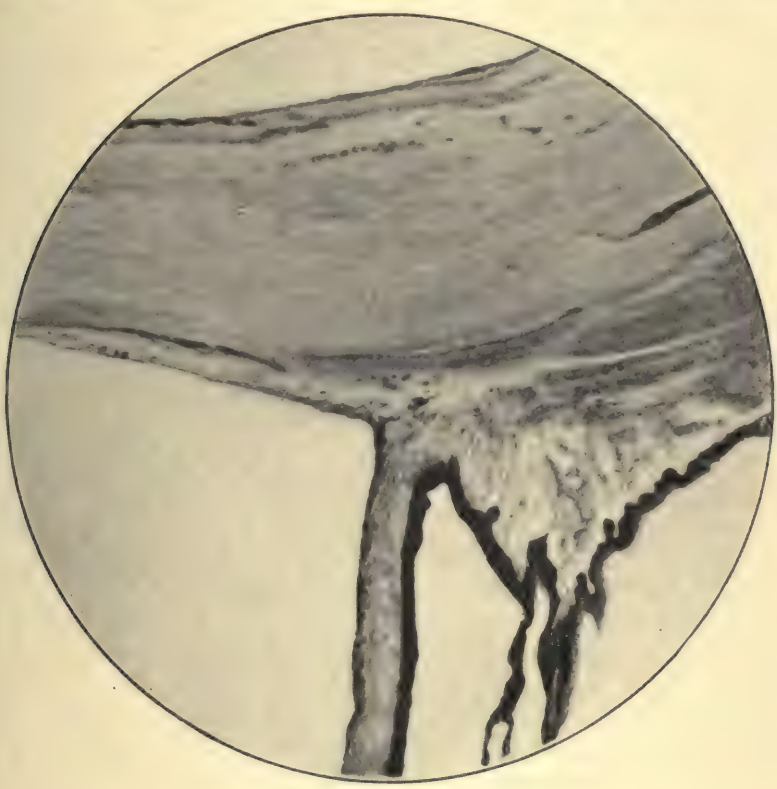


Fig. 534.

The Angle of the Anterior Chamber in a Case of Congenital Glaucoma or primary buphthalmos, showing a congenital adhesion of the root of the iris to the back of the cornea. The rest of the iris is widely separated from the cornea, the anterior chamber being very deep. (After Collins, in Posey and Wright.)

tension or to provide the surest and most permanent means of lessening the tension by constructing a channel of escape for the fluids from within the eye. The few who favor the hypersecretion theory endeavor to reduce the hyperemia which they regard as the cause of the disease by operations on the sympathetic system, while the vast ma-

jority of operators, who subscribe in the main to the principles of the retention theory, aim at some procedure which will be most effectual in increasing the possibility of outflow.

Operations for the cure of glaucoma may be divided into three groups:—Those on the anterior half of the eye; those on the posterior half; and those on the sympathetic system of nerves.

OPERATIONS ON THE ANTERIOR HALF OF THE EYE.

Paracentesis of the Cornea,

Efforts with the object of decreasing the hardness of the eyeball by permitting some of the contents to escape after a simple puncture of its envelope have been made for a century or more. Guérin of Lyons, according to de Wecker, having employed both corneal and scleral puncture for this purpose as early as 1769. In recent years, however, since it has become apparent that the effect of the procedure is but transient, it has been entirely superseded by other and more complicated operations, and only resorted to when a rapid and evanescent lowering of the tension is desired. The puncture, which lowers the tension by permitting of the escape of aqueous consequent upon the opening of the anterior chamber, is designated as *paracentesis of the cornea,* and is made as follows: After thorough cocainization of the eye, or, if the eye be very irritable and painful, after etherization or general anesthesation by a more rapidly acting and evanescent general anesthetic, a speculum is introduced, the globe steadied with fixation forceps, and the cornea incised in its horizontal plane 1 or 2 mm. from the limbus, by a small keratome. A Desmarres paracentesis needle, which consists of a small lance with an abrupt thickening of the base to prevent the needle from entering too deeply into the anterior chamber, was formerly employed, but either this instrument or a von Graefe cataract knife suffices. The aqueous should always be permitted to run off slowly, this being accomplished by gently pressing the posterior flap of the wound, until the greater part of the fluid has escaped, and by the slow withdrawal of the knife.

After the usual toilet of the eye and the instillation of eserine (gr. i to f. ℥i), a bandage is applied. Ordinarily the wound will close in from 12 to 24 hours. It may then be re-opened by a Daviel spoon if the tension has again risen, indeed the paracentesis may be repeated a number of times if the necessity arise.

Indications. In acute glaucoma to temporarily lower tension for the purpose of deepening the chamber and lessening the congestion of the eye before the performance of iridectomy. In secondary glaucoma to relieve blocking of the filtration angle from lens matter or inflammatory exudate or blood.

OPERATIONS WHICH AIM TO EFFECT A COMMUNICATION BETWEEN THE ANTERIOR CHAMBER AND THE SUBCONJUNCTIVAL SPACES.

Anterior Sclerotomy.

Considering that the relief of tension following iridectomy resulted more from the incision of the sclera and the opening of the spaces of Fontana than from the excision of a piece of the iris, de Wecker[16] in 1867 introduced an operation which he termed anterior sclerotomy, whereby he aimed to establish a cicatrix in the angle of the anterior chamber through which the intraocular fluids could filter out of the eye. In the following year, Stellwag von Carion practised this operation on the living subject, and two years later, in 1871, Quaglino reported five cases of glaucoma which he had successfully treated by sclerotomy. During this year de Wecker modified his original operation somewhat to avoid the prolapse of the iris which had attended some of his earlier incisions. This modification of the operation, which has been widely practised by others, is performed as follows:

After the pupil has been contracted ad maximum with a miotic, and the eye cocainized, the lids are separated with the speculum, and the globe steadied by grasping the bulbar conjunctiva a few mm. distant from and below the lower limbus of the cornea. A narrow von Graefe cataract knife is introduced 1 mm. from the outer corneal limbus, as represented at *a* in (Fig. 535) and made to emerge at *b*, at the other side of the anterior chamber. The incision is then continued upwards with slow sawing movements, the cutting edge of the knife being directed somewhat anteriorly, until only a bridge of tissue, about 2 mm. broad remains at *c*, this being left undivided to prevent iris prolapse. After the aqueous has been permitted to escape from the eye by cautiously tilting the edge of the knife slightly forward, the knife is slowly withdrawn. If the pupil is round, eserine is instilled and a bandage applied, but if it be oval or irregular, indicating a tendency of the iris to prolapse, the membrane should be gently stroked by a spatula and attempt made to restore the pupil to its normal form. In the rare cases that actual prolapse of the iris occurs, the prolapsed portion should be excised at once, and the sclerotomy converted into an iridectomy. Wiegman[17] recommends making the incision with a double keratome which he designed for the purpose.

Complications of Anterior Sclerotomy. In addition to prolapse of the iris which has just been referred to, when the chamber is very shallow, the operator may fail to enter the anterior chamber, the knife

[16] De Wecker. *Traité des Maladies des Yeux*, 1867.
[17] Wiegman. *Kl. Monatsbl. f. Augenheilk*, 1897, p. 277.

being inserted instead into the deeper layers of the cornea. To avoid this accident and also its converse of making the incision too far posteriorly and thereby wounding the lens, the best of illumination is necessary and the operator will do well to resort to the condensation of artificial light. In case the operator gives a wrong direction to his knife and splits the cornea or makes what is known as the *interlamellar incision,* the knife may be withdrawn and re-entered at a better angle. Should, however, the chamber have been opened and aqueous permitted to escape, the knife should be withdrawn and the operation postponed until the chamber has reformed. The same delay is advised if the operator realizes in time to desist, that the counter-puncture has been made too posteriorly.

After the toilet of the eye and the instillation of a miotic, a bandage is applied, the dressing being removed at the end of 24 hours. The lips of the wound may be found coaptated, and healing

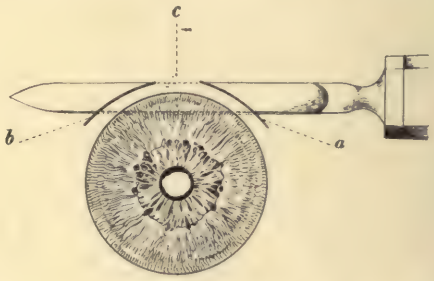


Fig. 535.

Anterior Sclerotomy. Showing the position of the knife in the eye during the incision of the sclera. It lies at least 1 mm. away from the limbus in the sclera.

may be perfected so that the thin cicatrix is barely visible. Oftener perhaps there is a gaping of the wound and the condition described by de Wecker as a *filtration-cicatrix* forms. This is less pronounced than the cystoid cicatrix which is observed after the prolonged and imperfect healing of incisions and wounds of the eyeball, and consists of a broadening and elevation of the scar with a slight bulging of the conjunctiva. De Wecker claims that such a cicatrix affords the maximum amount of drainage for the intraocular fluids, though he also asserts that a considerable degree of leakage may be attained through even a closely united scar.

Indications. According to de Wecker, anterior sclerotomy is particularly indicated prior to iridectomy when the tension is very high and the anterior chamber shallow. In chronic glaucoma in combination with miotics, he considered it to be the operation of choice. He also recommends it in hydrophthalmus, in hemorrhagic glaucoma,

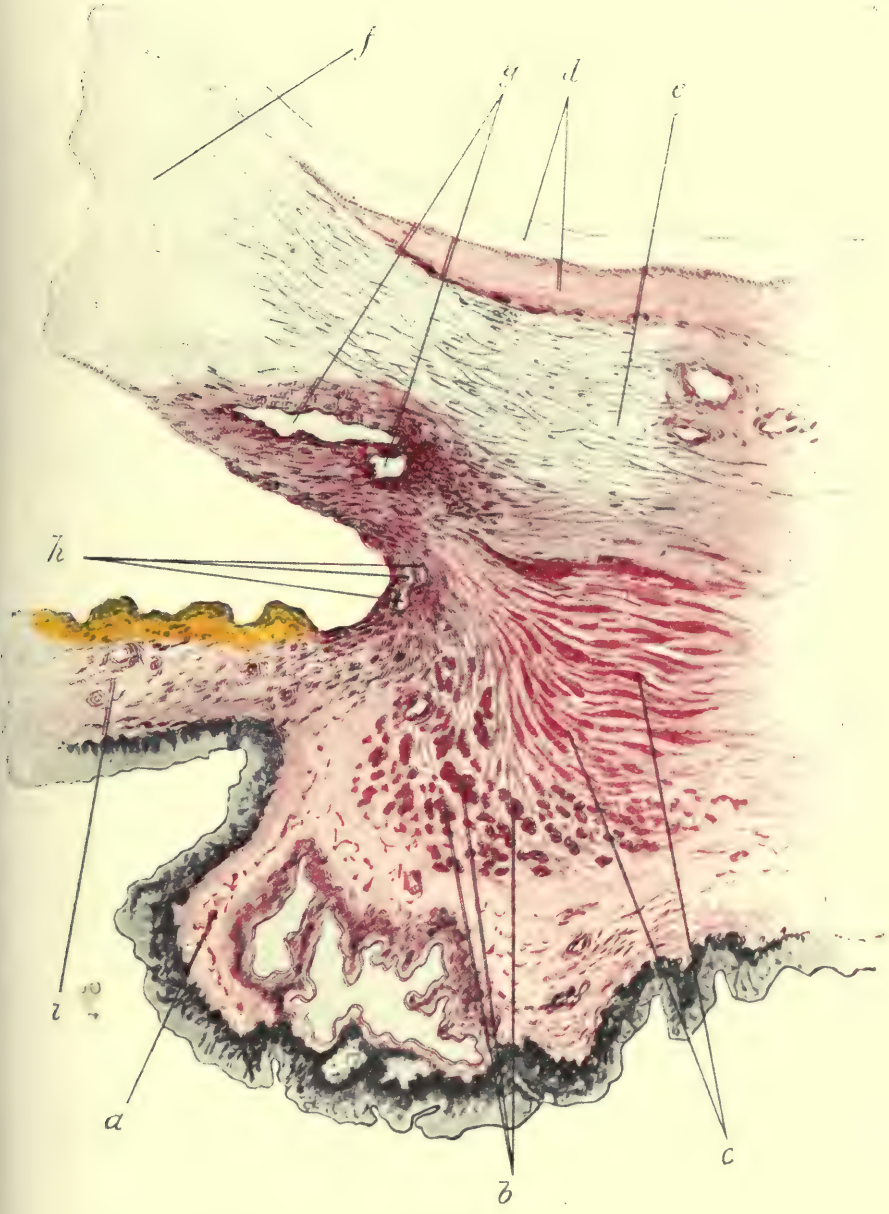


PLATE XI

Meridional Section of Ciliary Region of the Eyeball.

a. Ciliary process.
b. Circular fibers of ciliary muscle.
c. Meridional fibers of ciliary muscle.
d. Conjunctiva.
e. Sclera.
f. Cornea.
g. Canal of Schlemm.
h. Spaces of Fontana.
i. Iris.

and in cases of absolute glaucoma to lessen pain. Finally, he commends its performance in the prodromal period of inflammatory glaucoma when miotics are without effect.

After operating on a large number of cases, Panas[18] concluded that anterior sclerotomy occupies the middle place between a large peripheral iridectomy and repeated paracentesis of the cornea. In chronic glaucoma, he found that it was a useful supplement to miotics. In hydrophthalmus, however, it was as valueless as all forms of operation, and in his opinion did not remove the necessity of enucleation in absolute glaucoma. Although at one time extensively practised especially by French surgeons, sclerotomy has now but few advocates, as iridectomy with a scleral section has been shown to possess all the advantages of sclerotomy, while affording at the same time a possibility of re-establishing a communication between the anterior chamber and the canal of Schlemm.

Modifications of the Operation. Quaglino's[19] incision was much the same as is usually employed for iridectomy and was made with a large triangular keratome, the knife being entered 2 mm. behind the limbus. During the withdrawal of the keratome, the handle was tilted back to raise the blade and prolapse of the iris guarded against by permitting the aqueous to flow slowly off. Despite this precaution, however, and the use of eserine, prolapses were frequent, necessitating excision of the prolapsed portion of the iris.

Snellen[20] adopted Quaglino's method, as he found it less liable to induce prolapse of the iris. He treated a series of cases of bilateral glaucoma by iridectomy on one eye and sclerotomy on the other and found that the better vision was obtained by the latter. He, therefore, recommended sclerotomy, repeated if necessary as the initial operation, resorting to iridectomy only when the sclerotomy failed to prevent a rise of tension.

Bader[21] followed de Wecker's method in its essential details, but aimed at making the corneal puncture and counter-puncture as near as possible to and in front of the the insertion of the iris. He endeavored to leave a large bridge of conjunctiva, stretching across the sclerotic incision, and, with this in view, divided an extent of sclerotic equal to nearly a third of the circumference of the cornea.

Martin[22] precedes sclerotomy by paracentesis with a Desmarres needle introduced into the cornea at the vertical meridian 1 mm. from

[18]Panas. *Maladies des Yeux*, p. 521.
[19]Quaglino. *Ann. di Ottal.*, 1871, I, p. 200.
[20]Snellen. *Bericht der International Ophthalm. Kongress*, Heidelberg, 1888, p. 244.
[21]Bader. Sclerotomy versus Iridectomy. *Royal Lond. Hosp. Reports*, Vol. VIII, p. 430.
[22]Martin. *Annal. d'Ocul.*, Vol. XXXI, 1880, p. 236.

the limbus. If aqueous still remains after withdrawal of the needle, he permits it to drain off by the aid of a lance. The wound is then enlarged with one or two cuts of the iris scissors.

Both Panas[23] and de Wecker[24] advocated the operation of *cicatrisotomie* or *outétomie when rise of tension persists after iridectomy.* This consists in incising the cicatrix with a narrow Graefe knife, in order to divide the attachments of the iris in the angle of the cicatrix, the conjunctival bridge being left undisturbed. The writer has found this procedure of value in the several cases in which he has resorted to it.

In cases of glaucoma simplex of a suspected malignant type, Pflüger[25] incises the cornea as if for a broad iridectomy, but withdraws the linear knife with which the incision is made before the section is completed. If no decrease in tension occurs after the escape of aqueous, he considers the operation completed. Should, however, the tension fall, the incision is finished and the iris excised.

Irido-Sclerotomy.

As a satisfactory substitute for iridectomy and without disadvantages of prolapse of the iris and the formation of a cystoid cicatrix. Panas[26] devised this operation, which consists essentially of combining a de Wecker's sclerotomy with iridotomy for the relief of high tension in eye with extremely shallow or obliterated anterior chambers, such as occurs in pupillary occlusion when the posterior chamber is enlarged as a consequence of over-accumulation of aqueous. The incision is made with a Graefe knife below and to the outer side equidistant from the horizontal meridian and the lower limbus. As soon as the point of the knife enters the anterior chamber, it is plunged through the iris 8 to 10 mm. back of this membrane and then made to perforate the iris a second time at the counter-puncture which is situated at a point corresponding to the incision. The limbal tissues are next incised as in an ordinary sclerotomy to an extent of 2 to 3 mm. Finally, the cutting edge of the knife is turned somewhat anteriorly and as the instrument is slowly withdrawn, the remaining bridge of iris tissue is completely divided, a retraction of the central portion of the iris indicating that this has been accomplished.

Indications. Panas claimed that this operation was applicable to cases in which the increased tension was dependent upon an excessive accumulation of the aqueous humor, especially when the anterior

---

[23]Panas. *Soc. Franç d'Ophtalm.*, 1883.

[24]De Wecker. La cicatrisotomie ou outétomie. *Annal. d'Oculistique*, 1885, p. 10.

[25]Pfluger. Zur Behandlung des Glaukoms. *Bericht der Ophthalm. Gelsel*, 1882, Vol. 16, p. 152.

[26]Panas. *Arch. d'Ophtalm.*, Vol. IV, 1884, p. 481.

chamber was very shallow. It entailed but little risk of injury to the lens. He thought it particularly adapted to all cases of adherence of the iris with abolition of the anterior chamber, as, for example, in corneal staphyloma. It may also be performed as a preliminary to iridectomy.

Scleriritomy.

A quite similar operation has also been described by Knies. The steps of his method are as follows: After the pupil has been well contracted with eserine, a very peripheral incision is made, preferably above, either with a von Graefe or a Beer's knife. The incision engages the iris and a sort of irido-dialysis results from the division of the root of the iris from the sclera.

De Wecker regarded this operation with disfavor on account of the very evident danger of injury to the lens. A somewhat similar procedure to irido-sclerotomy was also introduced by Nicati[27] in 1894. This operation, which was termed *scleriritomy,* was particularly advocated in staphylomata, though found by its inventor to be of service in ordinary glaucoma.

The essential difference in the incision planned by Nicati is that the iris is incised from before backwards instead of from behind forwards as in the Knies[28] and Panas procedures. The incision is made precisely as in an ordinary sclerotomy, but in withdrawing the knife, it is given a rapid quarter turn, so that its plane is brought at a right angle to that of the iris with the edge backward. After the aqueous has escaped, the knife is rapidly withdrawn, incising the root of the iris. The lips of the wound are now made to gape so that the blood may be permitted to escape from the anterior chamber.

Combined Sclerotomy of de Wecker.

In 1894 de Wecker[29] introduced another operation, which has for its object the production of artificial dialysis. After the pupil has been contracted with eserine and the eye cocainized, de Wecker introduced the 6 mm. broad stop knife which he especially designed for the purpose, 1 mm. behind the upper limbus and the incision was made as for ordinary iridectomy. After the aqueous has flowed off slowly to prevent iris prolapse, a very delicate iris forceps with prongs well rounded off at the extremity are introduced into the anterior chamber and a fold of iris seized 2 mm. from the limbus. The iris is then gently drawn toward the centre of the cornea and traction made

[27]Nicati. *Rev. générale d'Ophtalm.*, 1894, p. 8, ref. *Jahresber. f. Ophtalm.*, 1894, p. 401.

[28]Knies. Ueber eine neue Behandlung des Glaucoms. *Bericht der Ophthalm. Gessel.*, 1893, p. 118.

[29]de Wecker. *Annal. d'Ocul.*, 1894, C. XII, p. 261.

until its periphery is detached from its root to the extent of 6 or 8 mm. A profuse hemorrhage usually follows, filling the anterior chamber. The forceps are then opened to prevent the iris being drawn back again to the periphery and held for a few minutes in the incision to facilitate the escape of blood and prevent the severed iris from prolapsing.

Incision of the Iris Angle.

This operation, devised by de Vincentiis[30] in 1895 and termed by him *incisione dell' angolo irideo,* aims, as its name indicates, in the incision of the tissues within the iris angle. For this purpose de Vincentiis employed an instrument with a needle-like shaft, at the extremity of which is attached a small sickle-shaped curved blade with the cutting surface on the convex side, the shaft being devised to completely close the incision made by the cutting portion so as to prevent the escape of aqueous. After eserinization and cocainization, the puncture is made obliquely through the sclera 1.5 mm. from the limbus on a level with the horizontal diameter of the cornea and made to enter the anterior chamber. (When operating on the left eye, the entrance puncture is made down and out; on the right eye, the operator standing behind the patient's head and operating with the right hand, up and out). The point of the knife is then passed across the chamber and, by giving the handle a slight rotary motion, incisions are made of 1 or more mm. in depth into the tissues of the anterior chamber. As the instrument is withdrawn, the convex cutting edge is made to sweep around the periphery of the chamber incising the angle from the point of first incision almost to the entrance puncture. Eserine should be instilled for some days after the operation.

Tailor,[31] de Vincentiis' assistant, gives the following indications for this procedure,—prodromal, acute and chronic irritative glaucoma; hemorrhagic glaucoma; chronic glaucoma simplex; secondary glaucoma in so-called iritis serosa (cyclitis) and anterior sclerotico-choroiditis.

Czermak,[32] however, thinks that an exact performance of this operation would only be possible in eyes with free anterior chambers, in which high tension is not the result of attachments of the iris root, but due to other causes, as, for instance, a blocking of the meshes of the pectinate ligament. Where the iris root is adherent, he claims the operation could easily result in extensive irido-dialysis.

From an anatomical examination made on 16 dead infants' eyes,

---

[30]de Vincentiis. *Atti. del XIII. Congr. della Assoc. Oftalm., Ital.; Annali di Ottalm.*, 1893, XXII, p. 540.

[31]Tailor. *Annali di Ottalm.*, 1891, XX, p. 117.

[32]Czermak. *Augenärtzliche Operationen*, Vol. II, p. 234.

upon which they had performed the de Vincentiis operation and de Wecker's sclerotomy, Valude[33] and Duclos[34] conclude that the same result is obtained from either operation and that either may be termed an incision of the iris angle. Clinical experience proved the procedure of value in their hands in prodromal and in some cases of chronic glaucoma and they deemed it worthy of trial in hydrophthalmus.

OPERATIONS WHICH AIM TO EFFECT A COMMUNICATION BETWEEN THE ANTERIOR CHAMBER AND VITREOUS.

Sclero-Cyclo-Iridic Puncture.

Chibret[35] effected a communication between the posterior and anterior chambers by making a flat puncture by means of a double-edged knife 3 to 4 mm. from the limbus, through the sclera into the angle of the anterior chamber. The knife is guided towards the anterior surface of the iris, the thickest portion of which is speared and the iris pulled towards the pupillary center, thereby loosening the attachment of the iris root to the posterior corneal surface; stronger tugging sometimes causes iridodialysis. This procedure is repeated in 5 to 6 meridians. Severe hemorrhage into the anterior chamber usually follows. Tension is markedly decreased in from 20 to 40 hours, and vision continues to improve for 8 days after the operation. The operation is repeated if the first procedure is unsuccessful; in very rare cases is a third operation necessary.

The Sterns-Semmereole Sclerotomia Antero-Posterior.

This operation is done after an ineffectual iridectomy, and consists in the introduction of a Graefe knife (2 mm. within the limbus) into the anterior chamber in the region of the coloboma. The knife is then passed posteriorly into the vitreous. The procedure resembles Antonelli's[36] peripheral iritomy, *(iritomie périphérique)*, and should perhaps only be attempted in blind eyes, because of the liability of producing a traumatic cataract. Antonelli employed a double-edged lance, which he introduced in the sclero-corneal region nearly perpendicular to the surface of the globe, but slightly obliquely. The point of the knife is thrust into the chamber, into the tissue of the iris, and its base incised by sweeping the knife around the periphery of the chamber to the extent of 5 to 6 mm.

A similar section of the iris root by means of a lance knife introduced perpendicularly into the vitreous through the cornea, scleral—limbus sclera and iris-zonula was attempted by Schnabel (1868-9) in

[33] Valude. *Ann. d'Ocul.*, 1898, XIX, p. 98 and 241.
[34] Duclos. *Ann. d'Ocul.*, 1898, XIX, p. 98 and 241.
[35] Chibret. *XII Intern. Congress, Sect. XI, Ophthal.*, 1898, p. 29.
[36] Antonelli. *Révue générale d'Ophtalm.*, 1896, p. 385.

a small number of eyes with absolute glaucoma, as well as in glaucoma after perforating serpent ulcer, but because of the uncertainty of results, he soon abandoned the operation.

Hern's Operation.

Hern[37] aimed at re-establishing the connection between the anterior chamber and the vitreous by means of what he termed a corneo-irido-vitreous puncture. This was accomplished as follows: After iridectomy, he introduced a double-edged Graefe cataract knife, about ⅓ to ¼ the size of the ordinary instrument, through the cornea about a line interval to the sclero-corneal junction, through the coloboma, into the circumlental space. Care should be exercised that the needle enters the cornea with its long diameter parallel to the antero-posterior axis of the globe, and with its cutting edge lateral, so that when the vitreous chamber has been entered, a lateral movement of the handle increases the extent to which the filtration angle is opened up and the connection between the chambers established.

Iridectomy.

In 1856 Albrecht von Graefe[38] discovered that iridectomy is capable of curing glaucoma. This must undoubtedly be regarded as the greatest contribution which has been made to ophthalmic science, for, while other measures and operative procedures have been introduced to combat this disease, the experience of more than half a century has served to convince the ophthalmic world that this operation is the most potent procedure of all. The distinguished discoverer of the operation was led to the supposition that iridectomy, by reducing the intraocular tension, might be beneficial in glaucoma as a result of the observation that partial staphyloma of the cornea sometimes flattens after iridectomy is performed. As will appear later, the full reason of the efficacy of iridectomy in glaucoma is still in doubt; the fact, however, of the cure of glaucoma, especially in its acute form, by iridectomy is established, and von Graefe must, therefore, be regarded as one of the greatest benefactors of the human race.

Before resorting to iridectomy in glaucoma of an inflammatory type and particularly if the tension is very high, it is usually desirable to reduce the tension somewhat by other means before entering the very narrow anterior chamber with a knife and excising a portion of the iris. This may be accomplished in a variety of ways. Undoubtedly the surest and quickest of these is posterior sclerotomy, and a number of operators, among whom may be mentioned Priestley Smith and Arnold Knapp, make puncture of the sclera a uniform

[37] Hern. *IX Internat. Congress of Ophthalmology*, Utrecht, Aug., 1899.

[38] v. Graefe. Ueber die Iridectomie bei Glaucom and über den glaucomatösen Process. *Archiv. f. Ophthalm.*, III, 2, 1857, p. 456.

procedure before iridectomy, the incision being practised, 24 to 48 hours in advance of the iridectomy.

Miotics, too, are of great value, often reducing the glaucomatous process in a few hours sufficiently to permit of operation. They should be invariably instilled into both eyes, as their use in the unaffected eye may prevent a post-operative acute attack of glaucoma, which has been observed not infrequently within a few hours after operation on the affected eye. One or two drops of a solution of eserine (gr. i to f. ℥ i) or of pilocarpine (gr. ii to f. ℥ i) may be employed and should be instilled into the eyes every hour, until the pupils become small and the inflammatory signs less. It must be cautioned, however, that even though this plan of treatment causes the glaucomatous symptoms to disappear, it is unwise to postpone operation in the inflammatory types of glaucoma and to rely upon the continuous use of miotics, for, while in a few cases apparently favorable results have been obtained by this means, in the majority the glaucomatous process will develop insidiously in spite of the drug and the adhesions between the root of the iris and the cornea will become closer, and the excavation in the head of the nerve deeper until vision is hopelessly compromised. Cocaine (3 to 5 gr. to f. ℥ i) may be used in conjunction with the miotics, increasing their action on the pupil and relieving pain.[39] The benefits to be derived from the lymphagogic effects of dionin have been highly lauded by Peter Callan and Casey Wood and this drug should be frequently instilled in from 5 per cent. to 10 per cent. doses. Massage of the eyeball is also of advantage, and hot compresses should be applied almost continually. In addition to these local measures, the patient should be placed in bed, the temple leeched, and morphine and chloral administered internally to relieve pain and secure sleep. Priestley Smith advises a dose of sulphonal or of chloral hydrate an hour before the operation so as to produce some degree of drowsiness, the patient then taking ether or chloroform more quietly, and the tendency to vomiting or excitement afterwards being often avoided. Full doses of salicylate of soda should also be administered to control the inflammatory process and relieve pain. The bowels should be freely opened.

Anesthesia in Iridectomy. While local anesthesia has the advantage of enabling the operator to gain the co-operation of the patient during the performance of the operation, and by its use the vomiting which is often so troublesome after ether is avoided, it is frequently difficult to produce perfect anesthesia by cocaine on account of the imperfect absorption of the drug by reason of the high tension. General anesthesia, therefore, should be employed unless contra-indicated by

[39] Wood's *System of Ophthalmic Therapeutics*, p. 810.

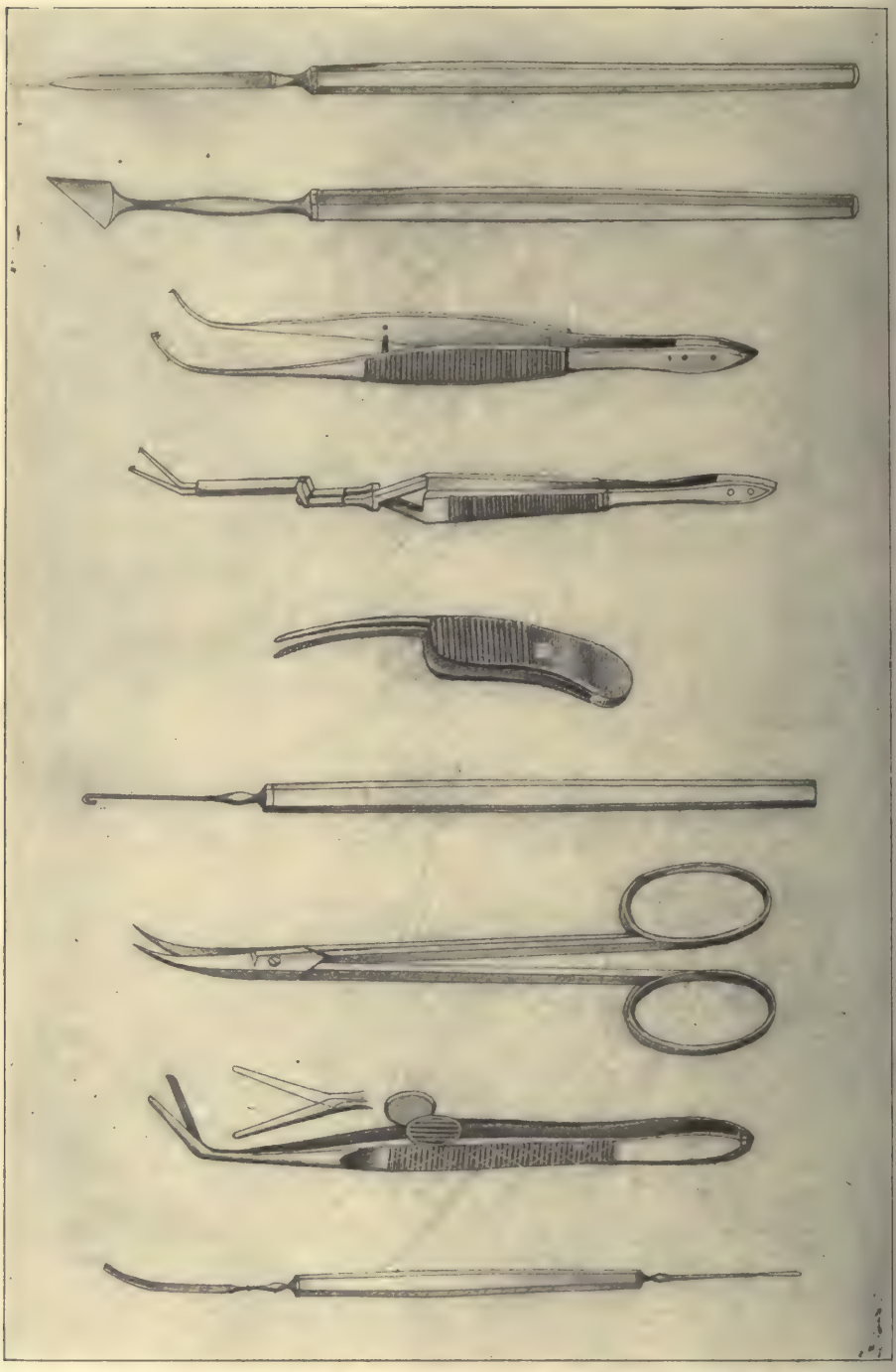


Fig. 536. Instruments for Iridectomy. a, von Graefe cataract knife. b, Angular lance knife. c, d, e, Iris forceps. f, Tyrrell's blunt iris hook. g, Curved scissors for excising the iris. h, de Wecker's scissors (*pince-ciseaux*). i, Combined spatula and blunt-pointed probe.

some grave systemic condition, in all cases where the glaucoma is of a congestive type, for this precedure, simple as it appears, is one of the most difficult which the surgeon is called upon to perform and demands that the eye be absolutely quiet until the excision of the iris is completed. Where serious renal or cardiac disease is present, it is usually advisable to delay the iridectomy for a time, and to reduce tension and lessen the inflammatory symptoms by an immediate posterior sclerotomy.

General narcosis should always be employed in children and in

Fig. 537.

Iridectomy for Glaucoma. Beginning of the Incision. The lancet is applied slantingly against the sclera at a distance of at least 1 mm.

nervous and ignorant subjects. Cocaine, 2 per cent., may be used in combination with adrenaline chlorid 1-3,000, but a miotic should be administered at the same time in cases where the inflammatory symptoms are not pronounced or where a general anesthetic is contra-indicated.

For the successful performance of iridectomy in glaucoma, certain points are essential. 1. The incision must lie well within the sclera. 2. The coloboma must be of good width; and 3. Some of the root of

the iris must be excised. It is also necessary to study the iris carefully before operation, in order that a section may be chosen for excision which is not too highly atrophic.

Instruments required are—Speculum, fixation forceps (2 pairs), keratome or von Graefe knife, iris forceps, iris scissors and repositor. (See Fig. 536.) If the anterior chamber is very shallow, a linear knife with a very narrow blade is to be preferred to a keratome, as the operator can much more readily avoid injury of the iris and lens by

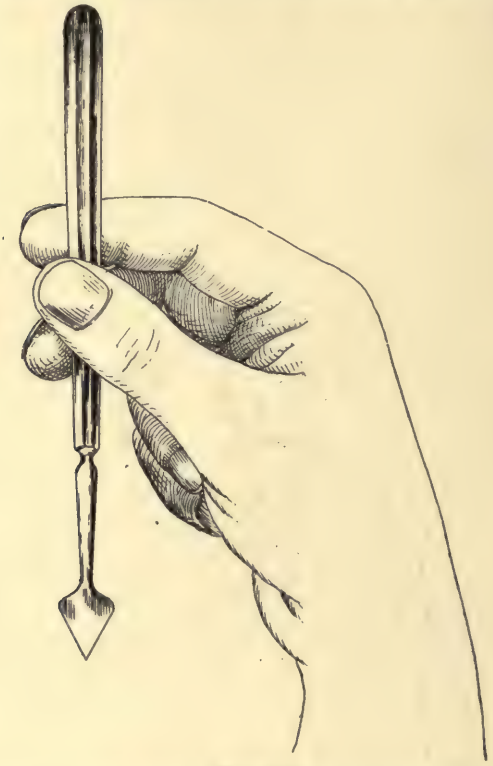


Fig. 538.

Method of holding the bent Keratome for Incision of the upper Corneal margin. (Czermak.)

his ability to change the direction of the knife and modify the position of the wound, than is the case with the keratome. The keratome has the advantage, however, of making a more regular wound, so that its edges come into better apposition, and by filling the wound until the section is completed, the aqueous is retained as long as possible, avoiding unnecessary prolapse of the iris.

If the keratome be employed, both eyes may be operated upon from behind, but if the Graefe knife is used and the operator is not am-

bidextrous, the left eye should be operated upon while the operator sits or stands upon the left side of the patient.

First Step. The Incision. After the introduction of a speculum, the eye is grasped with the fixation forceps near the limbus at a point opposite the site of incision. If the incision is made with a keratome, the blade which should be quite broad, should be applied somewhat per-

Fig. 539.

Making the Sclero-iridectomy. The Lance head has Entered the Anterior Chamber. (After Beard.)

pendicularly to the sclera 1.5 mm. posterior to the sclero-corneal junction (see Fig. 537), and cautiously and steadily pushed forwards until the tip of the knife is seen in the angle of the chamber. The handle of the instrument should be held between the thumb and index and middle fingers like a pen, (see Fig. 538), the operator steadying his hand by resting the two smaller fingers on the patient's forehead, and

the forward movement imparted to the blade by a simple straightening of the fingers. (See Fig. 539.)

After the tip of the keratome is seen in the angle of the anterior chamber, the handle of the knife should be gently depressed, bringing the blade parallel with the plane of the iris. The blade is then advanced, care being exercised to maintain the point in the plane of the iris, avoiding injury both to the iris and the cornea. As soon as an incision of 9 to 10 mm. in length is obtained, the handle should be slightly depressed and the instrument withdrawn slowly from the eye, giving the aqueous time to flow off gently. If a wider wound is desired, this may be accomplished by pressing the edge of the blade against the inner or outer angle of the wound as the knife is slowly withdrawn from the eye. This manœuvre should only be resorted to when absolutely necessary, as it is liable to make the incision irregular and thereby interfere somewhat with the prompt and perfect healing of the wound.

Sudden escape of aqueous should always be guarded against on

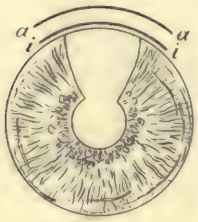


Fig. 540.

Iridectomy in Glaucoma. aa, External orifice of the Wound situated in the sclera; ii, Internal orifice situated at the sclero-corneal junction. (Fuchs.)

Fig. 541.

Diagram Showing the Point of the Knife Thrust just Through at the Limbus.

account of the danger of rapid forward prolapse of the lens, which may be followed by rupture of the zonula and luxation of the lens, rupture of the hyaloid membrane and prolapse of the vitreous. In eyes with very high tension, intraocular hemorrhages may also result.

If, instead of a keratome, a Graefe knife is employed and this—as has been said—is advised when the chamber is extremely shallow, the incision is made somewhat similar to that for the removal of cataract, with the important difference, however, that it must be somewhat shorter and must be entirely in the sclera. (See Fig. 540.) When ambidextrous, stationed behind the patient when operating on both eyes, or, if not, on his left side when operating upon the left eye, the surgeon steadies the eye by grasping the bulbar conjunctiva with fixation forceps 3 or 4 mm. from the lower limbus of the cornea and intro-

duces a narrow Graefe knife into the sclera about 1.5 mm. back of the corneal limbus, and from 2.5 to 3 mm. above the transverse diameter. (See Fig. 541.) As soon as the point of the knife is seen in the angle of the chamber, the handle is somewhat depressed and the blade is pushed slowly forwards in a plane parallel with the transverse diameter of the cornea, the greatest care being exercised to avoid wounding the iris and to make the counter-puncture at the same point in the cornea about 1 mm. within the limbus, so as to begin the counter-puncture. sclera as the initial puncture. If the chamber is exceedingly shallow, it

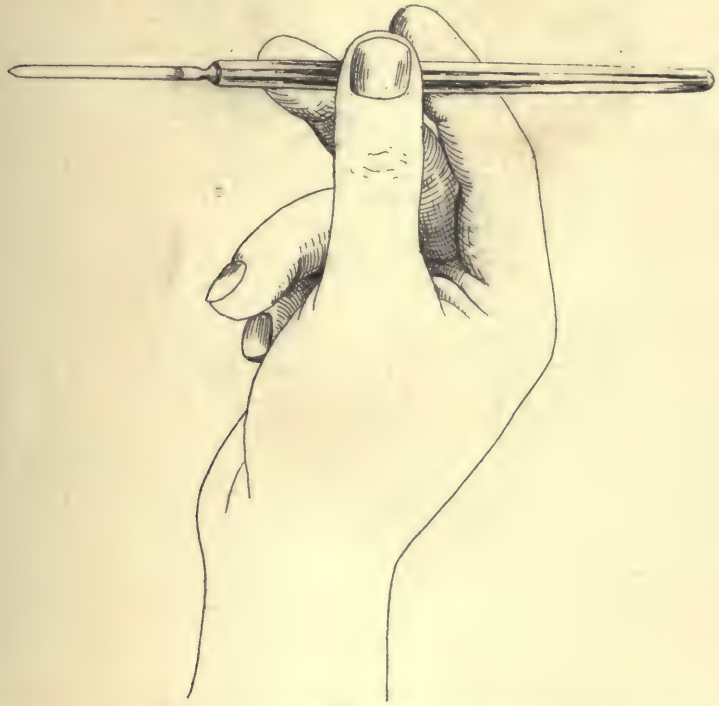


Fig. 542.

Method of holding the Straight Graefe for Upward Incision. (Czermak.)

will be necessary to avoid bringing the knife across the central zone of the iris, on account of the greater prominence of the lens and iris in that portion than at the periphery of the chamber, and to carry the point of the knife instead around the edge of the chamber, making it describe a segment of a circle between the puncture and counter-puncture. (See Fig. 542.) Should the operator fail to pierce the cornea before the anterior chamber has been entered, a so-called intra-lamellar incision will result. If this accident occurs, the knife should be withdrawn and another incision should be made at the site of the first, but with better direction.

As soon as the counter-puncture has been accomplished, the knife is pushed steadily upwards, keeping the wound entirely in the sclerotic, as in the operation of anterior sclerotomy, and is finally made to emerge about 2 mm. behind the limbus. The greatest care must be exercised not to permit the point of the knife to sink too deep into the angle of the chamber, but to keep the point of counter-puncture on exactly the same plane as the puncture, else a slanting incision will result with probable injury to the ciliary body. The conjunctival flap should now be reflected forwards over the cornea to permit of the ready excision of the iris, being easily replaced in its original position before the toilet of the eye has been completed.

Second Step. Seizure. Withdrawal and Excision of Iris. If the operation is being performed under local anesthesia, a drop of cocaine should now be applied directly to the iris, to render it still more insensitive. The operator then takes a delicate pair of iris forceps in his left hand and a pair of iris scissors in his right, relinquishing his hold on the fixation forceps to an assistant who is requested to keep the eye rotated somewhat downward. (See Fig. 539.) The iris forceps

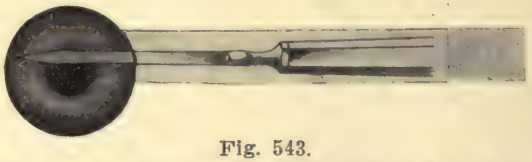


Fig. 543.

Diagram showing the Point of the Knife Directed toward a Point in the Cornea about 1 mm. within the limbus, so as to begin the counter puncture.

should be held like a pen, between the thumb and index and middle fingers, the little and ring fingers resting on the supraorbital ridge, the movements of the forceps being executed by extension and flexion of the fingers. (See Fig. 539.) The de Wecker scissors are usually preferred to the small scissors curved on the flat which were previously employed. They, too, like the iris forceps, should be grasped like a pen, by the ball of the thumb and index finger resting on the blades of the handle. With the blades of the forceps closed, the operator cautiously introduces the little instrument into one angle of the wound, and gently opening the forceps, grasps a small fold of iris near the pupillary margin. This portion of iris is drawn outwards into the angle of the wound and at the moment of strongest traction, the iris should be incised as near the base as possible by the scissors, the blades of which should be held parallel with the wound. (Figs. 544 to 546.) The iris is then torn from its base by deflecting the forceps to the opposite angle of the wound, and a final snip given the portion which has been dragged out of the eye. By introducing the forceps in the angle of the wound instead of through

the middle of the incision, a procedure which was first practised by Bowman, it is possible to make the base of the coloboma broader than the extent of the incision, while the peripheral incision of the iris, and the tearing it from its attachment, insures the excision of its root, without which an iridectomy for glaucoma may be considered a failure. Many operators, however, favor snipping the iris with one clip of the scissors, believing the method which has just been described, possesses

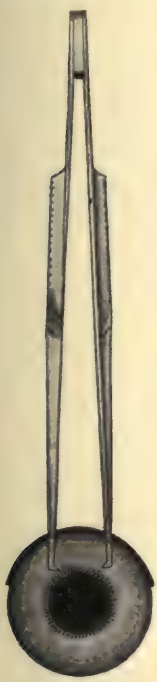


Fig. 544.

The Blades of the Iris Forceps held Close to the Pupillary Margin have just been opened.

Fig. 545.

The Blades have been Closed and have Seized a Fold of the Iris.

Fig. 546.

The Portion of the Iris, which has been Drawn Forward, is Cut off by the scissors brought from below.

no advantage over the single cut incision, while it prolongs the procedure and is more painful.

Third Step. The Toilet of the Wound. After the excision of the iris is completed, a delicate iris repositor should be inserted a short distance into the angle of the wound and incarceration of the iris prevented by gently stroking the pillars of the coloboma in the direction of the chamber. The repositor should then be made to traverse the entire length of the wound, to remove blood clots and to smooth out

the edges of the flaps. If there be much blood in the anterior chamber it may usually be removed by gently depressing the posterior lip of the wound with the repositor and by stroking the cornea in the direction of the wound. If the hemorrhage continues, it may be necessary to apply a pressure bandage without waiting for its control. If considerable incarceration still persists after the manipulation with the repositor, further excision of the iris must be resorted to, but great care should be exercised in introducing the forceps a second time to avoid injuring the lens capsule. The iris may be judged to be in proper position and the toilet of the eye completed when the lips of the wound are in perfect apposition and the two pillars of the coloboma are of the same height and situated in the curve of the former pupillary margin. The speculum is now withdrawn, and after eserine has been instilled into both eyes, a compression bandage is applied.

Accidents Complicating Iridectomy in Glaucoma.

If the incision has been too short and the opening into the chamber too small to permit of the ready opening of the blades of the forceps, the wound should be enlarged by one short cut of a small pair of a delicate curved scissors (Stevens' strabotomy scissors), which should be introduced into the outer angle of the wound.

Transfixion of the iris may occur either immediately after the chamber has been entered, in which event the knife should be slightly withdrawn and then pushed forward more anteriorly, or it may happen when the knife is more deeply engaged in the wound and its withdrawal necessitates loss of aqueous. If this latter occurs, the knife should be entirely withdrawn and the operation postponed until the chamber has reformed, the continuance of the incision being attended with too great danger of irido-dialysis and injury to the lens capsule.

Separation of the iris at its ciliary attachment to a greater or less extent and even complete detachment may occur if the patient make a sudden movement of the eye and the operator is not quick to release the iris from the forceps. Severe hemorrhage usually follows, which obscures the field of operation and prevents the proper toilet of the wound. As a rule, however, the blood is rapidly absorbed and only in rare cases is the blood clot converted into a dense cicatrix which occludes the pupil and contracts the coloboma.

It sometimes happens that the sphincter is not included in the excised portion. In this event a blunt hook should be inserted parallel with the anterior surface of the iris, and the narrow bridge of tissue broken through by traction with the hook or divided with scissors after it has been brought out of the eye.

If the aqueous is evacuated too suddenly, the abrupt lowering of the intraocular pressure may occasion *choroidal hemorrhage, rupture*

of the zonule and hyaloid, presentation of vitreous and *subluxation of the lens.* When, however, none of these disastrous consequences follow, and the iris alone is prolapsed into the wound, rather than excising the protruding membrane at once, Czermak advises replacing it before proceeding, in order to correctly gauge the amount of iris to be excised and to properly fashion the coloboma. He recommends excision without previous replacement, however, when the conjunctiva is so inflamed as to entail danger of infection; when the tension is high; when the lens is dislocated or abnormally small, as in hydrophthalmus, or when the vitreous is presenting; and in nervous persons and children who are under local anesthesia only.

Spontaneous rupture of the lens capsule may occur as a consequence of increased vitreous tension, immediately after completing the scleral incision or later with spontaneous discharge of the lens nucleus. More frequently the injury to the capsule is occasioned by the knife or by the forceps, but, even in the latter event, traumatic cataract of greater or lesser extent follows, which interferes with vision or is attended with even more serious consequences.

Luxation of the lens may follow rupture of the zonule either from too abrupt discharge of the aqueous, as has already been mentioned, or it may result from pressure by the instruments or from faulty manipulation. The edge of the lens is at once forced into the angle of the wound or into the coloboma if the iris has already been excised. Increase of tension follows and malignant glaucoma may result.

For the relief of this condition de Wecker[40] advised a sclerotomy opposite to the coloboma, the lens being replaced by pressure on the upper lid while the knife is still in the wound. Weber's procedure[41] for the same purpose is more complicated. This operator counselled making a puncture 8 to 10 mm. from the external limbus in the horizontal meridian of the eye with a doubled-grooved, so-called broad needle, the needle being rotated on its axis one-fourth to make the wound gape. The lens is then replaced by gradual increase of pressure on the upper lid or by a cataract spoon applied to the cornea perpendicular to the surface of the coloboma, the usual site of the luxated lens. A high degree of pressure should be maintained for a minute or more to permit of the re-accumulation of the aqueous. A slight pressure bandage is applied and the patient placed in the supine position for 24 hours.

Weber insists that the operation should be undertaken from 10 to 20 days after the luxation, the cicatrix being then sufficiently strong to withstand the pressure. If postponed until later, adhesions are apt

[40] de Wecker. *Chir. ocul.*, p. 155.
[41] Weber. *Arch. f. Ophthalm.*, XXIII, Part 1, p. 86.

to form between the lens and the iris and cicatrix which complicate the procedure, and in addition the eye is subjected to the danger of continued high tension.

If vitreous presents following rupture of the zonule *before* the excision of the iris and results in a sudden deepening of the chamber, as it escapes from the wound, the attendant prolapse of iris should be immediately excised, the iris being drawn out of the wound by means of a blunt hook. Both speculum and fixation forceps should be dispensed with, the lids being fixed by an assistant. If the prolapse occurs *after* the iris has been excised, the operation should be discontinued and, if considerable vitreous presents, it should be snipped off with scissors.

After very bungling operations the lens may prolapse into the wound and may subsequently become incarcerated, hernia lentis *(phakocele)*, and extraction may have to be resorted to.

Slow closing of the wound after iridectomy for glaucoma is always a serious complication, the attending reactive inflammation usually abolishing all the advantages which the operator had hoped for, the coloboma being choked with inflammatory material, the pillars of the coloboma incarcerated, and the eye slowly passing into a state of iridocyclitis or absolute glaucoma.

After-Treatment of Iridectomy for Glaucoma.

While some operators prefer a binocular bandage, a compress bandage upon the operated eye alone suffices, unless the patient is intractable and persists in rolling the unbandaged eye about and repeatedly opening and shutting it, thereby disturbing the operated eye. Under these circumstances both eyes should be closed. The patient should be confined to bed, but not necessarily in the supine position. If no incarceration of the iris is feared, the bandages should not be removed for 48 hours, when the lips of the wound will generally be found to be united and the anterior chamber reformed. The sclera adjacent to the wound is usually somewhat injected and the cornea may exhibit a delicate striated opacity. If at the first dressing the chamber is found reformed, the patient may be permitted to sit up by the side of the bed and, if the process of healing continues favorably, he may be permitted to walk about at the end of another 48 hours. The bandage should be maintained for ten days, unless it gives rise to conjunctival irritation, when it may be removed earlier, the eye being protected from the light by dark glasses.

It is usually the custom to instill miotics into the operated eye as well as its fellow at the time of the operation, and to continue the instillation at each dressing. Czermak, however, advises against this, as he argues that the miotic by reducing the tension may obscure an unsuccessful result from the operation, and may permit the eye to

pass into a condition of unsuspected chronic glaucoma, which would have asserted itself earlier if no miotics had been employed, and might have been relieved by a second operation.

Complications During the Healing Process in Iridectomy.

Delayed union of the wound may be caused by overlapping of the edges or by hemorrhages from the blood vessels of the iris or choroid. A continued compress bandage will usually overcome the latter difficulty unless it be caused by choroidal hemorrhage, in which event the eye is generally lost from irido-cyclitis.

When the incision has been made with a Graefe knife and a long conjunctival flap obtained, the edge of the wound may be kept separated by the fold of conjunctiva. Smoothing out of the flap and the application of the bandage will overcome this complication.

Incarceration in the wound of portions of the iris or prolapse of the lens or of the vitreous may interfere with the proper closing of the wound and may give rise to broadened, often imperfectly formed, fistulous cystoid cicatrices, ectasia of the broadened cicatrix or of the prolapsed iris with their sequelæ.

Tension may still remain high after iridectomy, and the anterior chamber be obliterated owing to a luxation of the lens or choroidal hemorrhage.

An expulsive hemorrhage of the choroid may follow the sudden decrease in tension and the eye lost by atrophy.

In other cases a gradual increase in tension supervenes without inflammatory symptoms and the eye passes into chronic glaucoma. In such cases iridectomy must be repeated, followed by a sclerotomy or cyclodialysis if necessary.

If the secondary rise in tension depends upon one of the margins of the coloboma becoming incarcerated in the lips of the wound, the liberation of the attached iris should be essayed by inserting a Graefe knife at one angle of the scar, carrying it through the anterior chamber until it reaches the other side of the site of adhesion and then bringing it out as far in the periphery as possible. The incision should then be completed with sawing movements. If the iris has not been separated from the cicatrix by this incision, the iris should be dragged out of the wound by iris forceps and as large a piece as possible excised.

Iritis and irido-cyclitis may follow iridectomy. The inflammation is usually of but a mild grade, in other cases, however, due to infection of the uvea at the time of operation or to a traumatic exacerbation of a previously existing insidious inflammation, the inflammation may assume a grave type and occlusion of the pupil and coloboma may follow, destroying the effect of the operation.

Panophthalmitis is very rare, and when it occurs, takes the same course as that observed after cataract operation.

Theories to Account for the Efficacy of Iridectomy.

The manner in which iridectomy reduces intraocular tension in glaucoma is still unsolved. Graefe himself attributed it to the reduction of the supposed secreting surface of the iris, but this theory has been disproved by the observations of a number of investigators who have shown that the iris has but little to do with the secretion of the intraocular fluid, the ciliary body being practically the sole source. In recent years careful microscopical study of glaucomatous eyes upon which iridectomy had been successfully performed for the relief of tension, but which were later enucleated upon account of some intercurrent affection, has shown that in these eyes either the obstructed passage for the exit of fluid at the angle of the anterior chamber was found opened up, or a new channel of exit had been established by the formation of what is termed a cystoid cicatrix.

After a lengthy presentation of the many theories which have been advanced since Graefe's epoch-making discovery, Czermak[42] finally summarizes the situation as follows: "Typical iridectomy with cornea-scleral incision abolishes glaucoma by separating the iris from the trabeculæ in the region of the wound and establishing at this point a permanent opening in the iris. The essential feature of the coloboma is its peripheral position. Iridectomy may also be efficacious by causing a detachment of the adjacent iris tissue. When this occurs and there is incarceration of the base of the iris and non-separation of the iris in the region of the wound, vicarious drainage is assured and a favorable result attained. Typical sclerotomy with clean, scleral incision, abolishes glaucoma by reopening the natural outlet of the intraocular fluid, in consequence of incision of the adherent iris and of its ligament." Czermak regards an iridectomy with a clean scleral incision as being nothing more than a sclerotomy with excision of the centrally situated portion of the iris. Irido-sclerotomy, the *incisione dell'angolo irideo* and sclerotomy act identically. Czermak thinks it is almost imposible to establish by operative means an entirely new channel of exit in cases where the natural channels have been permanently closed.

Prognosis After Iridectomy.

In view of these facts, it is evident that the prognosis for the restoration of vision after iridectomy depends upon the variety of glaucoma and the duration of the disease. In the acute and subacute inflammatory types, it may be said to exercise a curative action, and this is true in proportion to the time that the operation is performed after the appearance of the attack. If performed early, when the blocking of

[42]Czermak. *Die Augenaerztlichen Operationen.*

the chamber is due to vascular congestion and not to permanent causes, the filtration angle may be permanently opened, and the disease actually cured. In acute fulminating glaucoma the results of operation in recent cases are especially favorable, and if iridectomy is performed soon after the outbreak of the inflammatory attack, a degree of sight is secured, which is somewhat, but not much, smaller than it was before the attack, and the good results are permanent. The operation must be performed early, however, for if it is delayed and there has been no perception of light for two or three days, the chances of restoration of vision are very small. Full vision may, however, be regained after even some hours of absolute loss of light perception. In a certain small proportion of cases (malignant glaucoma) iridectomy even if repeated or associated with sclerotomy will not control the process, and blindness will ensue. As has been mentioned, operations done in the prodromal stage give particularly favorable results, so that this may be regarded as the time of election for iridectomy in inflammatory glaucoma.

The prognosis for conservation of vision for iridectomy in subacute glaucoma is also favorable and the operation should always be resorted to, though the emergency for an immediate operation is not so great, since miotics may hold the disease in abeyance for a time. It must be cautioned, however, that the continued use of these drugs in any form of inflammatory glaucoma is to be deprecated, as any permanent effect upon the progress of the disease can be effected by operation alone.

Wygodski's[43] table of results after iridectomy for acute glaucoma show that the prognosis was favorable in 80 per cent of the cases. Of 237 cases of glaucoma of all types iridectomized by Grosz, success was obtained in 96 per cent operated on in the prodromal stage and in 87 per cent operated on in the active stage.

Iridectomy of Most Value in the Acute Forms of Glaucoma.

While advocated by many surgeons, experience has shown that *iridectomy is not as efficacious in the relief of tension in chronic non-inflammatory glaucoma as in the more acute varieties.* This is doubtless due to the completeness of the adhesions in the angle of the chamber which form as a consequence of the long-continued increased pressure within the eye, rendering the removal of the root of the iris and the opening of the spaces of Fontana by operation impossible. Be this as it may, many operators have abandoned iridectomy in chronic glaucoma and have sought to cure this type of the disease by other surgical procedures, the majority of which have for their aim the creation of a means of filtration for the intraocular fluids out of the eye, by the production of more or less patulous cicatrices. Several years ago, removal

[43] Wygodski. *Klin. Monatsblätter f. Augenh.*, 1902, XLI, II, p. 177.

of the cervical sympathetic ganglion was favored by a few operators as a means of reducing tension in chronic glaucoma, but the operation was never widely practised and is now practically never performed.

Miotics versus Operative Measures in Chronic Glaucoma.

Of late years there has been an increasing number of ophthalmologists who have expressed the conviction that the operative form of treatment is not the only means of combating the increased tension of chronic glaucoma, and the continuous use of miotics has been widely extolled in the management of this non-inflammatory form of glaucoma. The writer[44] has long been an advocate of this form of treatment and in several communications has emphasized the beneficial effect which may be derived from these drugs. In his last paper he analyzed the histories of 65 cases of a pure type of simple chronic glaucoma, of which number all but 7 had used a miotic continuously for over a period of two years, and 12 for more than 10 years. As most investigators of simple chronic glaucoma urge the necessity of early operation in this type of the disease as well as in the inflammatory, and as it is generally recognized that the treatment and the prognosis of chronic glaucoma is much influenced by the stage in which the disease comes under observation, the cases were divided into three classes, according to their degree of development: (1) Beginning cases, (2) moderately advanced cases, and (3) very advanced or desperate cases. Of the 110 glaucomatous eyes which could be studied for statistical purposes, it was found that vision had improved or held its own during the entire time the case was under observation in 80 per cent. that there had been a slow deterioration of vision both central and peripheral in 11.8 per cent., while in 8 per cent. the miotics seemed to exert no influence, the eyes going blind and passing into absolute glaucoma.

Just as the advocates of iridectomy find beginning cases to be more amenable to treatment than those in the advanced stage of the disease, so cases treated by miotics from the early stages give better percentages in so far as the maintenance of central and peripheral vision is concerned, but the best results were obtained relatively in the far advanced or desperate cases. As even the most enthusiastic advocates of iridectomy realize the danger of operating on cases in this stage of the disease, it would seem that there was ground for the assertion that the best treatment of this type of cases consists in the energetic and continuous use of miotics, the pupils being kept at pin-point contraction. It must be emphasized, however, first, that miotics should be relied on as the sole means of treatment only in those cases which are free from attacks of so-called "glaucomatous congestion," the presence of such

[44]Posey. *Journal of the A. M. A.*, 1907, XLVIII, p. 676; *Ophthalmology*, April, 1907; *Journal of the A. M. A.*, Oct. 24, 1908, Vol. LI, pp. 1389-1394.

congestive symptoms being in the opinion of the writer the chief indication for iridectomy; and second, that to gain the full benefit of miotics, it is necessary that they should be administered properly. Beginning in doses small enough to avoid creating spasm of the ciliary muscle, and rapidly increasing the dose until the pupil of the affected eye is strongly contracted, this degree of contraction should be maintained as long as life lasts by gradually increasing the strength of the solution, from time to time, and by instillations of the drug at intervals of every three or four hours. Conjunctival irritation may be avoided by employing only fresh and sterile solutions of the drug. Suitable cleansing washes should be administered, and attention given to the general health and especially to the condition of the blood vessels. Careful and repeated correction of the refraction error should be made and restrictions enjoined on the use of the eyes.

The adjoining table was prepared by the writer to demonstrate the *comparisons of a series of cases of chronic glaucoma treated by miotics and by iridectomy.*

TABLE OF COMPARISON OF SERIES OF CASES OF CHRONIC GLAUCOMA TREATED BY MIOTICS AND BY IRIDECTOMY.

	Zentmayer and Posey: 167 Cases.		Posey's series: 110 Eyes. (Miotics) Per cent.	Bull's First Series; 94 Eyes. (Iridectomy) Per cent.	Bull's Second Series; 115 Eyes. (Iridectomy) Per cent.	Schleich.		Koster; 20 Eyes. (Iridectomy.) Per cent.	Grosz; 62 Cases. (Iridectomy.)	Uhthoff. (Iridectomy.) Number of Cases not mentioned. Per cent.	Hippel. 66 Eyes (Iridectomy.) Per cent.
	Miotics. Per cent.	Iridectomy Per cent.				102 Cases. Iridectomy Per cent.	46 Cases. Miotics. Per cent.				
Central Vision Maintained in	84	80	80	25	18	15.1	39	26	70	50	14
			On an average of 5 yrs. and 3 mos. in each case.	On an average of 2 yrs. and 5 mos. in each case.					"Favorable result attained." Details of what constituted "a favorable result" not given.	(Actual improvement of V. in 5.)	("Cures for the present")
Gradually lost in.....	16	20	20	61	70	76.5	61	74		50 (40 gradual; 10 rapidly.)	41, no aggravation of symptoms after 2 yrs. 20, no aggravation of symptoms after 5 yrs. 14, no aggravation of symptoms after 10 yrs. 9, no aggravation of symptoms after 14 yrs. 26, slow loss in vision. 20, went blind in spite of operation.
Form fields Maintained in.....	68.70	50	45	14	0						
Gradually lost in.....	31.25	10	55	75	100						
Ave. period of time each patient was under observation.....			5 yrs. and 8mos.	4 yrs. and 10 mos.	5mos. 11 yrs.						

From a further study of Schleich's cases, Koetzle reports that the results of medicinal treatment in the Tübingen clinic in comparison with the operatives one are so interesting that miotics should have the fullest trial.

Treatment of Hemorrhagic Glaucoma.

Owing to the sublying arterial sclerosis which is present in cases of hemorrhagic glaucoma and the danger of hemorrhage following the diminution of intraocular tension, iridectomy is seldom practised in this variety of glaucoma, less radical surgical measures, conjoined with the use of miotics, and remedies directed to the sublying physical condition being preferred. Thus Bull recommends a careful corneal paracentesis, after complete cocainization, the aqueous being permitted to flow out only drop by drop from the anterior chamber. The temple is then leeched, after which a solution of eserine sulphate, one grain, and pilocarpine hydrochlorate, four gains to the ounce, is instilled every hour until the eye softens. Hot compresses are then applied until all pain has disappeared. Twenty drops of the fluid extract of jaborandi are prescribed three times daily to lower intravascular tension. Repetition of the paracentesis may be necessary. A careful regimen of the life of the patient must be enjoined.

On the other hand, Weckers[45] does not believe that iridectomy is always contraindicated in hemorrhagic glaucoma. He thinks that there are two distinct classes of this type of the disease, one with marked degeneration of the intraocular vessels, readily ruptured by the sudden release of the intraocular tension following an iridectomy, and another class of cases in which the vascular changes are not so marked. In this latter class iridectomy relieves the action of hypertension in the blood vessels and permits the repair of existing vascular lesions.

Treatment of Buphthalmus.

The treatment of this condition is very unsatisfactory. Miotics are of but little avail and no form of surgical intervention has been devised which can cure or even check the process. Iridectomy is not followed by good results, nor have its substitutes proven of service in this destructive form of glaucoma. The best results seem to be attained by repeated posterior sclerotomies.

Treatment of Secondary Glaucoma.

If the rise of tension be but temporary, as in traumatic cataract or serous iritis, paracentesis of the cornea will suffice to relieve the glaucoma. If, on the other hand, the glaucoma is due to definite anatomical conditions which occasion a blocking of the angle of the chamber, more radical measures are necessary, and different procedures will have to be

[45]Weckers *The Ophthalmic Year Book*, 1909, p. 211.

resorted to, to relieve the various sublying causes which have been mentioned elsewhere.

If this form of glaucoma is consequent upon the blocking of the angle of the chamber from anterior synechia, the operation of synechiotomy *(vide intra)* is advised. When the rise of tension has been caused by seclusion of the pupil, iridectomy is indicated, the glaucoma being relieved by the re-establishment of a normal circulation between the posterior and anterior chambers. The removal of the iris is very difficult, however, in cases of total posterior synechia, and is often unsuccessful. If iris bombé is present, Fuchs' operation of transfixio iridis iridis is the operation of choice.

In secondary glaucoma after wounds and operations due to prolapse of lens capsule or hyaloid membrane of vitreous between the lips of the corneal wound, tension may usually be relieved by carefully dividing the prolapse with a sharp knife-needle.

When the glaucoma has been occasioned by a dislocation of the lens into the anterior chamber, this structure should be cautiously removed by an incision with a Graefe's knife, after the pupil has been contracted as much as possible with eserine. Some loss of vitreous usually follows this procedure.

If the increase in tension has been set up by a lens that has been luxated into the vitreous, the removal is attended with still greater danger of loss of vitreous, and is best accomplished by first bringing the lens into a normal position by a needle passed posteriorly through the sclera and then removing it by means of a scoop.

Modifications of the Procedure of Iridectomy.

Although favoring the linear knife, Scherk[46] thought the lancet more practical in certain cases. To combine the advantages of both these instruments, he devised a bayonet-shaped knife with a blade 15 mm. long inserted at a little more than a right angle into a 20 mm. long shank, which is fixed again at a little more than a right angle into an ordinary knife handle.

Czermak is a warm advocate of a method practised by Dehenne[47], especially in primary glaucoma with a shallow or obliterated anterior chamber and in iris bombé. This operator punctures the outer inferior quadrant of the globe 1.5 mm. from the limbus with a very fine linear knife. The sclera is perforated until the point of the knife appears in the angle of the chamber. The scleral incision is then enlarged parallel to the limbus 4 to 5 mm. by slow sawing movements of the knife. No counter-puncture is made. During this manœuvre the aqueous escapes

[46]Scherk. Ein schmales Iridektomiemesser. *Klin. Monatsbl. f. Augenheilk*, 1873, p. 101.

[47]Dehenne. *Arch. d'Ophtal.*, 1888, p. 120.

drop by drop and tension is reduced very gradually. The iris is then withdrawn and excised. Czermak makes his incision in the upper, outer quadrant and usually fixes the eyeball with two pairs of forceps.

Streatfeild[48] also avoided counter-puncture and made much the same incision as Dehenne, employing the point of a broad cataract knife for the purpose.

Deschamp's method[49] of making an incision through the limbus and adherent iris, thus reopening the posterior chamber, seizing the posterior surface of the iris and then withdrawing and excising that membrane, also resembles Dehenne's.

Gayet[50] has devised an operation which has been somewhat modified by Dufour[51], which is applicable to cases in which the anterior chamber is so shallow that it is impossible to open it without wounding the iris if the ordinary plan of incision is followed. In this procedure the surgeon grasps the conjunctiva with Monoyer's fixation forceps, applying one point above and the other below the cornea. The incision is then made at the scleral-corneal junction with an ordinary Desmarres scarificator through the cornea from without inwards, the membrane being divided layer by layer by gentle sawing movements, care being exercised to keep the knife constantly in contact with the tissues to prevent the incision from becoming jagged. As soon as a drop of aqueous presents, the scarificator is dispensed with and the incision is finished with small blunt-pointed scissors, or, as recommended by Dufour, with small bent knives (iridesis knives). The excision of the iris now follows in the usual manner. General anesthesia is desirable. Gayet deemed his procedure particularly adapted to cases of acute glaucoma with opaque cornea. The complications consist in hemorrhage into the anterior chamber and injury of the iris by the scarificator, but the blood is rapidly absorbed, and if the iris is injured, it can readily be excised.

Dianoux[52] substituted a Beer's knife for the scarificator and a Weber probe-pointed lachrymal knife for the scissors. Beard[53] suggests that a little instrument, one less likely to wound the iris, would be a small model of the Desmarres keratome.

When the anterior chamber is very shallow, Czermak cuts the conjunctiva close to the limbus with fine pointed scissors, and dissects back a flap embracing nearly one-half of the corneal circumference and about

---

[48]Streatfeild. *Congrés de Londres*, 1873, compt. rend., p. 154-159.
[49]Deschamp. *Annal. d'Ocul.*, 1902, CXXVII, p. 101.
[50]Gayet. D'un procede réglé d'ouverture de la chambre antérieure de l'oeil, lorsque celle-ci est effacée par suite de l'accolement de l'iris á la surface postérieure de la cornée. *Bulletin et Mem. Soc. Franç. d'Ophtalm.*, 1884, p. 41.
[51]Dufour. *Annales d'Oculist.*, Jan., 1901.
[52]Dianoux. *Bull et Mém. de la Soc. Franç. d'Ophtalm.*, 1884, p. 44.
[53]Beard. *Ophthalmic Surgery*, p. 446.

4 to 5 mm. high at the centre. After checking any slight hemorrhage with adrenaline and ice cold sponges, he makes an incision with a well curved scalpel, through the sclera, 1 mm. from the edge of the clear cornea, cutting carefully, layer by layer, until the anterior chamber is opened. If the iris prolapses, it is replaced, and the well-rounded point of a fine Louis' scissors is introduced, and the incision is broadened to one or both sides. The original incision needs to be only large enough to admit the scissors' point, and should be slightly oblique instead of vertical, the back of the knife being inclined almost toward the equator of the ball. In this way the inner wound is almost exactly opposite the boundary of Descemet's membrane, and a coloboma 7 to 8 mm. wide can be secured. After introducing the iris forceps, they are opened wide so as to secure a broad fold of iris, the iris is grasped in the center and drawn gently toward the pupil, the forceps being pushed forward. This loosens the ligament, and the iris is then drawn outward and excised.

In cases in which the iris is adherent to the cornea, and is more or less atrophic, Czermak[54] combines Heine's cyclodialysis with the iridectomy. Following Heine's method, he frees the attachment of the ciliary body and the adhesion of the iris with a delicate spatula, and then performs the iridectomy. He has done the combined operation in a number of cases, but is unable to make a definite report upon his results. In order to avoid seizing the ciliary body with the forceps, if it prolapses into the wound, he has had constructed a forceps with protecting plates. Usually at the conclusion of the operation, he passes a silk suture through the edges of the conjunctival wound, and if the ciliary body prolapses, he makes a superficial scleral puncture.

In cases of acute glaucoma with abolition of the anterior chamber and the iris reduced to a narrow rim or wholly lost to sight beneath the corneo-scleral margin, Burnett[55] modified the incision after the method originally introduced by Streatfeild in his operation for cataract, as follows: An opening is made into the anterior chamber from without, by successive strokes with the point of a Graefe knife, following the curves of the corneal base as far behind the clear cornea as was desirable for the most peripheral position of the wound, the essential idea being to cut the layers at the sclero-corneal junction as evenly as possible throughout the whole extent of the incision. The bottom of the wound thus carefully made, finally gives way at some point, and through this opening there is a gush of aqueous and usually a prolapsed iris. A triangular knife with a bulbous point is then introduced into

[54]Loco cit, p. 220.

[55]Burnett. The Manner of Making an Iridectomy in Acute Glaucoma. *Am. Journ. Ophthalm.*, April, 1902, p. 114.

the wound and the section of the already thinned tissue completed by the sharp sides of the knife. The iris now usually occupies the opening and is seized with the forceps and cut in the usual way.

A. A. Bradburne (p. c.) has adopted the plan (when operating for *quiet, simple glaucoma*) of removing only the base of the iris, taking particular care to leave intact the periphery. To do this well he finds it advisable, after the usual incision has been made with a keratome, to grasp the *center* of the iris and to make gentle traction to the *center* of the pupil so as to first *dislocate* the *root*. It is then withdrawn and cut off in the usual manner.

The advantages of this modification are, (1), it produces little disfigurement, (2), it causes very little shock, (3), it does not destroy the optical properties of the iris as regards its light protecting or visual properties, (4), it does not allow the iris to fall back into the anterior chamber as the more drastic operation does, (5), it lessens the need for so large an incision and therefore lessens the liability to prolapse of the lens, corneal astigmatism and, finally, does not prevent other operations being performed if necessary later on. Personally he has never found occasion to do anything further in any case in which he has employed it.

Sclero-Iridectomy.

Terson, Sr.[56], aimed at insuring the beneficial action of both operations by combining iridectomy with sclerotomy—*sclero-iridectomy*. A sclerotomy is first performed after the method of de Wecker, the puncture, however, being made much higher, in line with a point 2 to 3 mm. from the upper end of the perpendicular corneal margin, the counter-puncture as a consequence occurring only slightly above the nasal extremity of the horizontal meridian. The incision is continued with sawing movements and the wound of entrance is made much longer than that of the counter-puncture by raising the handle of the knife. To prevent the partially divided conjunctiva over the wound of entrance from interfering with the excision of the iris, the knife is thrust forward a second time after withdrawal and a portion of the conjunctival bridge divided. The flap thus formed is reflected over the cornea, and the iris then drawn out and excised as peripherally as possible. A resultant narrow coloboma is thus secured above.

This operation resembles somewhat the *sclero-dilatatorectomy* of Logetschnikow[57] in which the operator aims to perform iridectomy with preservation of the pupillary margin in combination with double sclerotomy. If the iris is merely incised, the operation should be designated *sclero-dilatatorotomy*.

Filtering Cicatrix.

As has already been stated,[58] de Wecker had long ago suspected that it was not the removal of the iris which diminished the intraocular tension in glaucoma, but rather the formation of the "filtering cicatrix."

---

[56]Terson, Sr. (a) *Mémoires du Cong. d'Opht. de Paris*, Jan. 26, 1885; (b) *Société de Med. de Toulouse*, Jan. 11, 1889.

[57]Logetschnikow. *Bericht über die 23 Versammlung der Ophthal. Gesellsch.*, Heidelberg, 1893, p. 21.

[58]Page ——.

In recent years this theory has gained many adherents and ophthalmological journals have contained a remarkable number of diverse methods to obtain filtration areas. While there are still those who believe that a soundly healed cicatrix possesses filtration properties, the majority of observers, perhaps, have now arrived at the conclusion that such is not the case, and consider that a firmly healed cicatrix in the sclera is no more permeable than normal tissue. The newer procedures, therefore, aim at the removal of some of the sclera, in the hope that the remaining parts, even after healing, will be permanently less resistent, and will thus allow the intraocular fluids to pass more rapidly from the eye.

One of the chief opponents of the theory of filtering cicatrices is Henderson[59], who contends that the success of the operative procedure in glaucoma does not result from the particular method of incision adopted, but depends, as has been well shown clinically since Graefe's time, on the iridectomy and on the state of the iris. He bases this statement upon anatomical investigations which demonstrate in his opinion that, while corneal incisions heal and cicatrize, the cut iris surface forming the base and pillars of the coloboma, never does, but always remains as when first severed, thus acting as a drainage area, the efficacy of which depends on the condition of the iris at the time of operation.[60] Thomson and Grimsdale[61] give an impartial review of the question of the so-called filtering cicatrix. Very recently, also, Ballantyne[62] has contributed an extremely valuable paper upon the same subject, and has given a most lucid review of all the newer operations for glaucoma.

The Lagrange Irido-Sclerotomy Operation.

Of all the operations designed to establish a filtering cicatrix, that devised by Lagrange[63] and designated by him as *irido-sclerotomy, or* iridectomy combined with sclerotomy, has probably met with the greatest favor. To obtain this permanent filtration cicatrix, after eserinization an oblique incision is made through the sclera by means of a narrow Graefe knife and a large conjunctival flap secured. This is obtained by making a peripheral section of the sclero-corneal margin with the knife and, as soon as the edge of the knife reaches the upper limit of the anterior chamber, it is turned backward and brought out through the sclera obliquely (see Fig. 547). The conjunctival flap is then turned back over the cornea (see Fig. 548), and the fragment of

---

[59]Henderson. On So-Called Filtering Cicatrices in the Treatment of Glaucoma. *The Ophthalmoscope*, Dec., 1907, p. 701.

[60]Thomson. The Question of the So-Called "Filtering Cicatrix." *The Ophthalmoscope*. Feb., 1908, p. 84.

[61]Grimsdale. Some of the Newer Operations Upon the Eye and Its Appendages. *The Ophthalmoscope*, Nov., 1908, p. 875.

[62]Ballantyne. *The Ophthalmoscope*, July 1st, 1910, p. 507.

[63]Lagrange, (a) *Revue générale d'Ophthal.*, 1906, p. 358; (b) *Arch. d'Ophtalm.*, 1906, XXVI, p. 481.

sclera that was left attached to the cornea is removed by means of a fine pair of delicate curved scissors (see Fig. 548), following which an iridectomy is performed. The conjunctival flap is now replaced and a bandage applied.

This operation opens a large filtration passage for the intraocular fluids and the prompt healing of the wound, with its mucous covering prevents prolapse of the iris.

Although Lagrange advocated iridectomy in all cases in his first communication, he no longer judges the procedure to be necessary in all instances, reserving it for cases in which for any reason, such as hy-

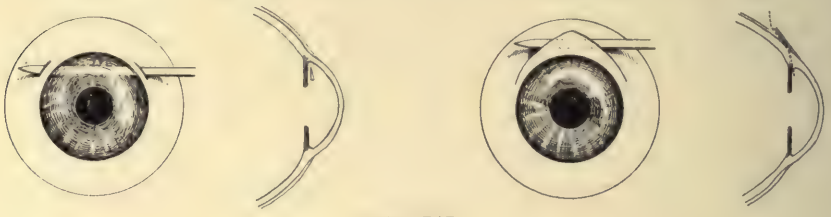


Fig. 547.

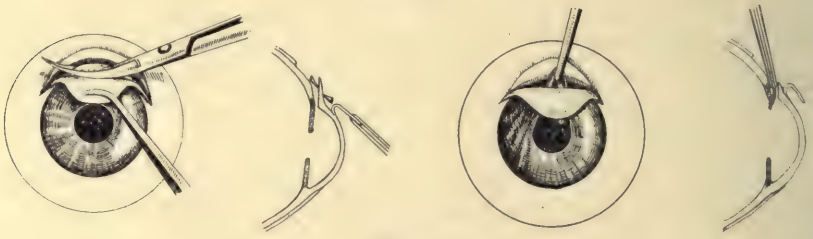


Fig. 548.

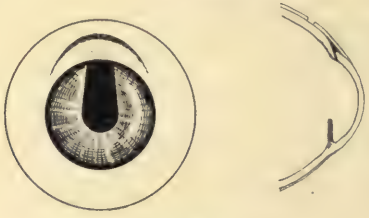


Fig. 549.
Illustrating Different Steps in the Lagrange Operation.

pertension, prolapse is to be feared. Under no circumstances must iris be left between the lips of the wound.

While Lagrange holds that it is necessary to open the anterior chamber, Bettremieux[64] thinks that a removal of but a portion of the thickness of the sclera suffices. His procedure is as follows: After raising a flap of conjunctiva from the neighborhood of the limbus above the

[64]Bettremieux. *Bull. de la Soc. Belg. d'Ophtal.*, No. 23, p. 36, 1908; *The Ophthalmoscope*, Oct., 1908, p. 818.

cornea, a medium-sized needle, curved and flattened towards its point and firmly grasped in a needle holder, is thrust superficially into the sclera tangentially to the upper edge of the cornea, so as to become fixed in the capsule of the eyeball. A small shaving of the sclera, about ½ mm. thick, 1½ to 2 mm. broad and from 2 to 3 mm. long, is then excised by means of a narrow Graefe knife. The scleral slip is then freed from the conjunctiva at each end and the mucous membrane brought together over the wound by fine catgut sutures.

Terson believes that a filtering cicatrix is not necessary or desirable to cure an ordinary glaucoma, but approves of the procedure of Lagrange when a peripheral iridectomy has produced only a temporary effect.

Weeks[65] has done the Lagrange operation for glaucoma 37 times. It has given him very good results, superior, he thinks, to the results obtained by the classical operation, in that there is filtration through the new formed tissue at the site of the wound for a longer period of time. He does not think that permanent filtration is established in many cases, if in any. He makes the incision a little shorter than recommended by Lagrange.

Greenwood[66] reports most encouraging results from the Lagrange operation in 4 cases of glaucoma simplex. He believes the operation or one of its modifications has come to stay, because it is a distinct advance in the operative method of chronic glaucoma, in that it makes the effect of an iridectomy more marked at first and more permanent later, thus retaining the vision which existed at the time of operation much longer than can be hoped for from miotics, simple iridectomy, sclerotomy or cyclodialysis. Ballantyne[67] has summarized Lagrange's conclusions as follows: "The results of sclerectomy vary according to the degree of hypertension of the eye operated on. Three varieties of cicatrix are distinguishable according to the amount of sclera excised: (1) that in which there is mere thinning of the sclera owing to the excised portion not reaching the posterior surface of the cornea (conjunctiva smoothly covers the cicatrix); (2) that represented by a subconjunctival fistulette, due to excision of the whole thickness of the sclera, in an eye with moderate tension (the conjunctiva lies smoothly over the cicatrix); (3) the fistulous cicatrix with an ampulliform elevation of the overlying conjunctiva, resulting from excision of the whole thickness of the sclera in an eye the seat of high tension. In cases of high tension, even a simple sclerotomy will allow ample filtration, owing to the gaping of the wound, while in cases without

[65] Weeks. Personal Communication.
[66] Greenwood. *Trans. Ophthal. Section A. M. A.*, 1910.
[67] Ballantyne. *The Ophthalmoscope*, July 1st., 1910.

elevation of the tension, sclerotomy will be quite ineffectual. Lagrange therefore proposes the following rules of procedure: (a) If tension is normal to +1, do sclerectomy without iridectomy, the amount of sclera excised being inversely proportion to the degree of hypertension. (b) If tension is + 1 to + 3, do sclerotomy-iridectomy, the iridectomy being added to avoid entanglement of the iris. Lagrange does not recommend his operation for acute glaucoma. It is especially adapted for cases of chronic simple glaucoma."

Some operators have *combined sclerotomy with an irido-dialysis.* Thus Knies[68] expressed his opinion that the value of iridectomy was chiefly in the fact that removal prevented prolapse and adhesion. He, therefore, in dealing with glaucoma cuts through the attached base of the iris with the knife at the time of the section of the globe, making an operative partial irido-dialysis. He calls the method "irido-sclerotomy."

Ciliarotomy.

Within the past few months, Abadie[69] under the supposition that irritation of the rich circular nervous plexus which covers the ciliary zone immediately behind the insertion of the iris, may induce glaucoma, undertakes to relieve the condition by *division of the ciliary zone,* or, as he terms it, by *"ciliarotomy."* The *technique* of the operation is as follows:[70]

"A fold of the bulbar conjunctiva is raised by means of forceps towards the supero-external quarter of the cornea. The conjunctiva, raised with fine dull-pointed scissors, is divided in the direction of the corresponding meridian of the eye for about 1½ *centimètres.* The conjunctiva being thus cleft, one takes the superior flap and with ordinary strabismus scissors detaches it from the sclera while raising it up, taking care, in order to disengage it well, to liberate its attachment to the sclero-corneal limbus by small cuts of the scissors. The inferior flap is treated in a similar way. By these means a large triangular surface of the sclera is bared, the base of which is formed by the cornea and the apex by the terminal point of the conjunctival opening made in the first instance. A couple of sutures are now passed through the two conjunctival flaps, whereby they may be brought together in order to cover the wound which is about to be made in the ciliary region.

The sutures once in place, both are pulled outward in such a way as to expose the field of operation. Then, seizing with fixation forceps the conjunctiva and the episcleral tissue at the level of the inferior conjunctival flap, so as to keep the eye perfectly steady, the point of Richter's triangular knife is inserted just at the junction of sclerotic and cornea, immediately behind the insertion of the iris. It is gently plunged, so to speak, into the globe, its point being directed towards the centre, and its blade in the corresponding sense of the eye. In consequence of its triangular form, its propulsion towards the centre of the eye causes its cutting edge to divide the ciliary zone. By slight sawing movements of the blade, this section is enlarged in such a way that it attains a length of from 7 mm. to 8 mm.—that is to say—about the extent

---

[68]Knies. Ueber eine neue Behandlung des Glaucoms. *Bericht der Ophthalm. Gessel.* 1893, p. 118.

[69]Abadie. Section de la zone ciliaire ou ciliarotomies. *Archiv. d'ophtalm.,* May, 1910, p. 262.

[70]*The Ophthalmoscope,* July 1st, 1910, pp. 503 and 504.

of the ciliary nervous plexus. The knife is then withdrawn. Contrary to what might be expected, only one or two drops of vitreous issue from the incision, which is only a mere slit.

Then, by tying the two sutures previously placed in the conjunctival flaps, the conjunctiva is brought together, thereby covering the scleral surface and the incision that has just been made."

Abadie asserts that his procedure is especially adapted to cases of glaucoma which persist despite iridectomy. The results have been uncomplicated, without luxation of the lens, or intraocular hemorrhage.

Incarceration Methods

While the operators who designed the procedures which have just been described aimed at establishing a permanently permeable cicatrix by a filtration scar which was free from iris tissue, others have attempted to accomplish the same result by producing incarceration of the iris. As aptly summarized by Ballantyne:[71]

"The authors of the incarceration operations base their proposals on the following three facts: (1) That in such an operation as extraction of cataract the entanglement of iris in the wound frequently leads to the formation of a cystoid, or, at least, a fistulous, scar, and that the eye in consequence remains permanently soft, with evidence of leakage of aqueous fluid into the subconjunctival tissue; (2) that in iridectomies done for acute glaucoma the best and most permanent results are found in cases where the iris has become entangled between the lips of the wound; and (3) that the risk of infection of a prolapsed or incarcerated iris is greatly less in the cases where the latter is covered with conjunctiva. If the beneficial effect of iridectomy in many cases is due, not to the iridectomy, but to an accidental inclusion of iris, why not, they ask, set out to produce such an inclusion in a regulated and deliberate manner, adding the conjunctival covering to avoid risk of infection?"

The two chief advocates of the incarceration method are Herbert and Holth. In a recent communication Herbert[72] gave the details of a variety of methods which he had employed to obtain a permeable scar by producing a large prolapse of the iris by a free sclerotomy. Finding that the iris dammed up the fluids, he was led to excise a small portion of this membrane, thereby establishing a fistule. In other cases a large conjunctival flap was made above the section and a fold of conjunctiva tucked between the lips of the scleral wound. As soon as the anterior chamber reformed, the fold of conjunctiva was distended by the aqueous and a bulging prominence formed above the wound. In favorable cases this wound did not heal firmly and a subconjunctival fistule formed which permitted the free escape of aqueous. Another procedure consisted in fastening the fold of conjunctiva to the wound by tying the two threads of a suture into a knot, and then passing it through the middle of the conjunctival flap; the needle is then passed into the anterior chamber and the suture brought out through the upper limbus of the cornea, the two ends of the thread being tied on the surface. The thread is removed after 24 hours.

---

[71] Ballantyne. *The Ophthalmoscope*, July 1st, 1910, p. 510.

[72] Herbert. Subconjunctival Fistula Formation in the Treatment of Primary Chronic Glaucoma. *Trans. Ophthalm. Soc. U. K.*, 1903, p. 324.

Wedge-Isolation Operation.

More recently, Herbert[73], has devised another operation, which has been termed the *wedge isolation operation*. By this procedure Herbert claims to avoid what he considers the faults of the Lagrange operation, i. e., too long an incision, the excision of too large a portion of iris, and the lack of means of regulating the size and depth of the portion of excised sclera. He reports that 38 such wedge-isolation operations have been performed with uniform and trustworthy results in the production of a filtering scar. It is claimed that the smallness of the incision makes the operation a safe one, while if the procedure fail, subsequent operations of a different nature are not interfered with. The writer describes the operation as follows:

"The knife used is an old and worn Graefe, ground down to a breadth of about 4/5 mm. It must taper gradually to the point. One blade which served us very well tapered from point to heel. It measured about 1¼ mm. in width at the heel and was 26 mm. long. The eye is fixed with forceps at the inner

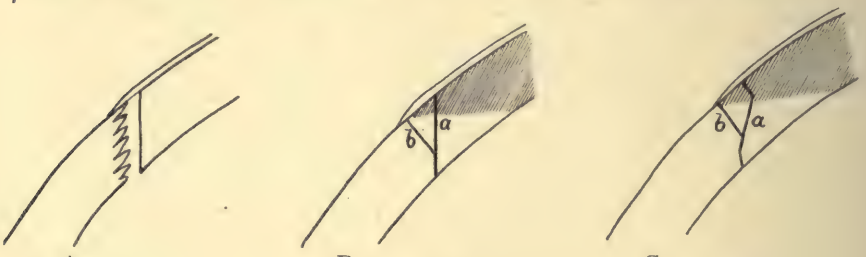


Fig. 550.

The Wedge Isolation Operation.

B. and C. Show the Directions of the Incisions Correctly, but the position of A should probably be more to the right, in order to make the diagrams applicable to the middle of the transverse wound. Possibly there the apex of the wedge reaches the posterior surface of the cornea. (Herbert. *The Ophthalmoscope*, June 1st, 1907.)

side. After the counterpuncture has been made, there is little or no trouble in the matter of fixation during the slow section, because with so small an incision the knife lying in the wound suffices almost to prevent upward rotation of the globe. The conjunctival puncture is made 1½ mm. or 2 mm. above the projected line of incision, the loose conjunctiva being then pushed down in a fold with the point of the knife. In making the sclero-corneal puncture quite close to the cornea, the direction of the blade is nearly transverse. It must point but little downwards, since otherwise a fair share of the section is not accomplished in the puncture. Our very small primary incision is largely accomplished in the acts of puncture and counter-puncture, and if too much tissue is left to be cut in the counter-puncture, the latter can not be made without the use of an objectionable degree of force. The cutting edge of the knife is directed either exactly upwards or slightly backwards, although this latter inclination makes the counter-puncture a little less easy. The course of the blade within the anterior chamber need not extend to more than 3 mm. or 4 mm. The point is then brought a little forward to engage in the

[73]Herbert. The Filtering Cicatrix in the Treatment of Glaucoma; An Improved Operation. *The Ophthalmoscope*. June, 1907, p. 292.

posterior surface of the cornea. It should reach the scleral surface quite close to the corneal boundary. As it slowly emerges, some aqueous usually leaks out beside it, raising the neighboring conjunctiva before the latter is fully pierced. As soon as the point is well through, the blade is turned to direct the cutting edge downward, and the puncture and counter-puncture are enlarged thus.

This downward enlargement is commonly sufficient when almost the whole width of the blade can be seen through the cornea, the knife being momentarily twisted to show this. It is needed to allow the blade to be twisted freely and placed correctly for the forward cut (b). But before this secondary forward cut is made, the primary incision may be further enlarged upwards and somewhat backwards, taking care to leave a bridge of superficial sclerotic still undivided. (See Fig. 550).

The blade is then twisted, and the secondary incision (b) forward and upward, exactly perpendicular to the surface, is made with slow, gentle, to-and-fro movements. The knife-edge should aim to reach the surface almost exactly at the corneal margin, about the middle of the small incision. With ordinary care, gentleness and deliberation, there is no difficulty in completing this forward sclero-corneal cut without dividing the overlying conjunctiva, even though the latter be not elevated at all by aqueous. The primary upward incision is then completed subconjunctivally to isolate the wedge. The latter should be quite narrow. Its vertical measurement should be ½—2/3 mm. In completing the section, therefore, the knife-edge has usually to be turned more or less forward, as in Fig. 550. It is obvious that precision and care are needed in locating and directing these cuts correctly, especially the forward cut (b), since quite small variations may influence the depth of the wedge very considerably. (See Fig. 550).

It is easy, by twisting the blade a little when making the counter-puncture,

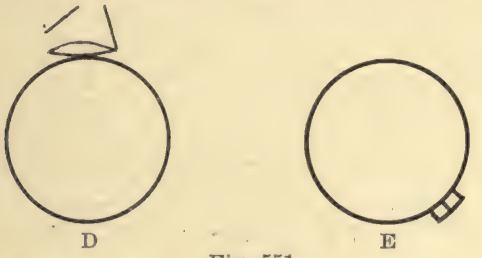


Fig. 551.

The Two Upper Lines in Fig. D Represent the Conjunctival Incisions nearly Completing a Conjunctival flap. (Herbert. *The Ophthalmoscope*, June 1st, 1907.)

to produce a free escape of aqueous beneath the conjunctiva, thus insuring it against the possibility of accidental section. But, if this be done, one can not see well enough through the distended mucous membrane for the exact outlining of the sclero-corneal strip of tissue.

It still remains to cut a conjunctival flap, for a sufficient opening is required for the performance of an iridectomy, and it appears advisable to arrange for elastic shrinkage and subsequent distension and elevation of the conjunctiva over the wound. I prefer, however, to leave a small bridge of conjunctiva undivided above, to exclude the possibility of the flap becoming bent downwards over the cornea, as happened in one "jagged incision" operation upon an acutely glaucomatous eye, where the conjunctiva was somewhat swollen.

The iridectomy is, where possible, merely a small peripheral buttonhole, made solely for the purpose of preventing adhesion or incarceration of iris in the wound. For the proper performance of this minute iridectomy, and to aid in the subsequent retraction of the iris, the pupil should be always contracted, if possible, by eserine beforehand.

It may be broadly stated that the scheme and purpose of this operation are much the same as in Lagrange's sclerotomy. In the latter operation, by excision with scissors, a groove is left in the sclerotic of somewhat uncer-

tain depth. In the plan which I have followed, the sclero-corneal gap remains covered in by the detached strip of tissue, and, being cut from within, should bear a more definite and constant relation (as yet undetermined) to the deep surface of the cornea. The dependence upon absorption of tissue—a process of nature—in the final adjustment of the result appears sound. At least, it was thus that we came to explain the consistent results obtained formerly as regards tension, in our operations by subconjunctival prolapse of iris.

We commonly bandage the eye for a day only, and afterwards protect it with a shield. If there is any tendency to the formation of synechiæ, as there frequently is after operation for acute or sub-acute glaucoma, atropin is used freely. The tension of the eye should be watched for some time. In one or two highly congested eyes massage was needed the day after operation to reduce a return of tension, evidently due to glueing together of the wound surfaces by lymph and blood-clot. In a number of eyes the tension remained very low, —2 or —3, for a variable period after operation. The longest period yet observed of this low tension was one of from three to four weeks."

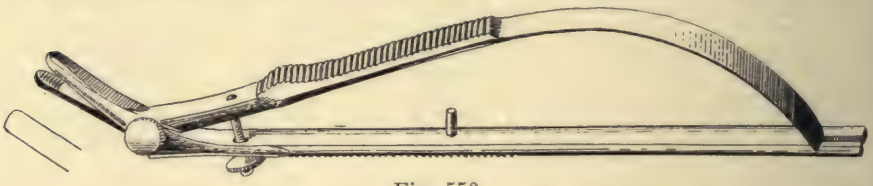


Fig. 552.

Vacher's Punch-forceps Modified by Holth for Sclerectomy.

Holth's Formation of a Cystoid Cicatrix.

To lessen the dangers of infection and sympathetic disturbance, following the purposive formation of a cystoid cicatrix, Holth[74] devised an operation which he designated *Iridencleisis Anti-glaucomatosa,* and by means of which he aimed at producing subconjunctival incarceration of iris tissue combined with extra-sphincteric iridectomy. The incision is usually made above with a keratome, about 10 mm. behind the corneal limbus, beneath the conjunctiva, the knife being brought out at the corneal scleral margin. The anterior chamber is now opened and a convex fold of iris brought into the wound, establishing a fistu-

Fig. 553.

Holth's Elbowed Fixation Forceps Useful for Fixation of the lower part of the limbus when the eye must be turned downwards far enough to make the subconjunctival incision above with the keratome.

lous opening between the anterior chamber and the exterior which is covered by a broad fold of conjunctiva. (See Fig. 556.) The anterior chamber may remain unrestored for several months after this

[74]Holth. Iridencleisis Antiglaucomatosa. *Ann. d' Oculist.*, May, 1907, p. 345.

procedure, but tension keeps normal. Schiötz advocates this procedure, but makes a normal iridectomy with a large conjunctival flap, obtaining incarceration of a small portion of the iris. He was able to secure a filtering scar in only about 28 per cent. of the cases, although Holth claimed that he secured this type of scar in 75 to 85 per cent. Vollert[75] thinks Holth's is the best operation for the relief of glaucoma. To avoid the danger of infection through the cystoid scar, he recommends, however, the transplantation of a flap of conjunctiva after Kuhnt's method.

Maher[76], while advocating iridectomy in the early stage of chronic

Fig. 554.

Holth's double Blunt Hook for Turning Back the Conjunctiva after Subconjunctival Incision with a Keratome.

glaucoma, believes this operation to be useless in cases of long standing, where it is no longer possible to reopen the filtration angle by this method. He believes that an operation should then be preferred which establishes a cystoid cicatrix, and has introduced a method which he claims has given him excellent results during the past 13 years. His method of procedure is as follows:

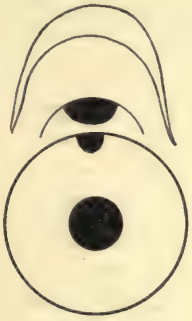


Fig. 555.

Diagram of Sclerectomy (by Holth's method) of the Anterior Lip with a Punch-forceps after Incision with a Narrow von Graefe Knife.

"Having made the usual scleral section with a broad keratome, I drag on the iris with one or, preferably, two iris forceps—one in each hand—detaching its base at the part corresponding to the scleral section. The loop of iris thus formed is left well prolapsed for a week, when it is snipped off with an iris scissors level with the sclerotic at each angle of the wound. Sometimes I vary the procedure by cutting the iris at the time of the operation at one angle of the wound, and then, by dragging on it with the iris forceps, tear

[75]Vollert. *Ophthalmic Year Book*, 1908, p. 192.

[76]Maher. On the Treatment and Prognosis of Primary Glaucoma. *The Ophthalmic Review*, July, 1909, p. 185.

it away from its attachment corresponding to the section, in the hope, if possible, of re-establishing the communication between the anterior chamber and the canal of Schlemm. Instead of now completing the iridectomy, I leave prolapsed, at the other angle of the wound, a large portion of the tag of iris thus formed, and at the end of a week, snip it off level with the sclerotic. By this means I generally obtain small flat cystoid cicatrices. The same result may often be obtained, but with less certainty, by performing an iridectomy in the usual way, but cutting the iris so that it is left slightly entangled at one, or both, angles of the section."

He admits that eyes with cystoid cicatrices run a risk of infection and that the entanglement of iris no doubt increases the liability to sympathetic ophthalmia. These sequelæ, however, he has but rarely met with.

The Use of the Scleral Trephine in Glaucoma

Fergus[77] has modified the Lagrange operation by removing the

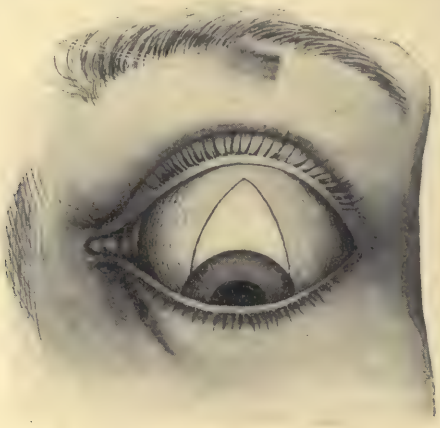


Fig. 556.

Elliot's Operation. *First stage of operation.* Showing the site of the triangular flap when made above the cornea.

piece of sclera with a *trephine* instead of with scissors and forceps, combining, as it were, trephining with cyclodialysis. The technique consists in dissecting a conjunctival flap up towards the cornea and laying it over the corneal surface, when a small disc of sclera is removed by a Bowman's trephine one or two millimeters from the apparent corneal margin. A repositor is then passed between the sclera and the ciliary body and iris into the anterior chamber, keeping it in close contact with the sclera and cornea. The conjunctiva is then stretched in position.

Elliot's Operation for Glaucoma.

Elliot[78] has adopted much the same procedure and has operated

[77]Fergus. Trephining for Glaucoma. *The Ophthalmoscope*, Feb., 1910, p. 74.

[78]Elliot. *The Ophthalmoscope*, Dec. 1st, 1909.

on a series of 50 cases without septic accident, indicating to him that there is little risk in dissecting up the large conjunctival flap. He cautions against the danger of making the trephine hole too far out and thus tapping the supra-choroidal space instead of the anterior chamber. If this happens, the anterior chamber does not empty, the tension is not well lowered, and, if any effort is made to excise the bulging uveal coat, is vitreous loss will occur. (See Figs. 556 and 557.) Iridectomy is resorted to if there be a tendency to incarceration.

To quote the author's own description:[79]

"The operation may be performed under the local influence of cocaine and adrenalin, dropped into the sac. If there is much pain or congestion, or if the patient is unruly, a hypodermic injection of morphin may be given twenty minutes before the operation. In recent cases we have been using subconjunctival injections of cocaine and adrenalin with excellent results. The patient looks down, and a large triangular flap of conjunctiva is dissected up from above the cornea, the attached base of the triangle lying at the sclero-corneal margin. Experience has shown the importance of dissecting this flap right up to the limbal attachment of the conjunctiva. The flap

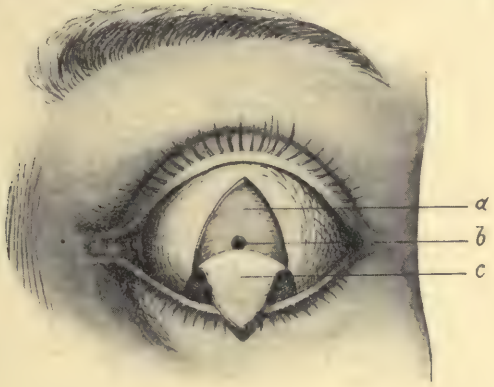


Fig. 557.
Elliot's Operation.

Second Stage of Operation. (a) Raw surface left by raising the conjunctival flap. (b) Trephine hole. (c) Flap of conjunctiva turned down over the cornea.

is turned down on the cornea. The spot selected for the trephining should be as close to the limbus as possible, and should be prepared by using the scissor points freely, either cutting or scraping or both, right down to the scleral coat. It is important that no conjunctival tissue be left, as otherwise it will catch in the trephine and tend to draw the flap into the latter as it is working. I never pull on the flap, but simply steady the globe by pressing on the cornea through the down-turned flap; I find this quite sufficient to effect the purpose of keeping the eye at rest in the proper position. The trephine is used with quick light movements, and care is taken that its first application suffices to bite into the sclera, before it is raised to see the progress made. Once a clean ring is thus started, it is very easy to replace the trephine in it. At first the operator feels the need of frequently removing the trephine to watch progress, but he soon learns to know by the feel when he is through. As soon as the anterior chamber is tapped, aqueous

[79]Elliot. *The Ophthalmoscope*, July 1st, 1910, p. 483.

Fig. 558.
Verhoeff's Sclerostome, Ready for Use.

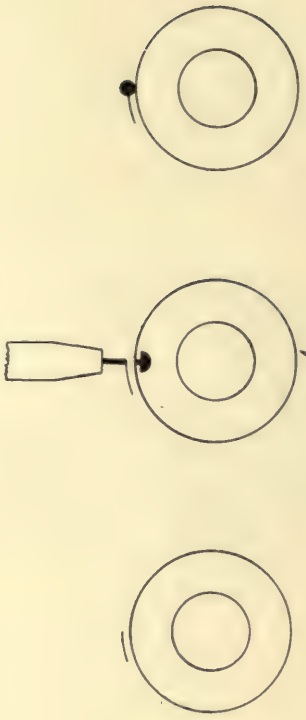


Fig. 559.
a. Position of incision. Conjunctival flap not shown.
b. Sclerostome in Position Ready to Cut.
c. Fistula Completed. Buttonhole in iris not shown.

fluid wells up alongside the trephine; even apart from this, there is a curious sucking sensation which tells one the trephine is through. Moreover, the patient often helps by a slight movement due to the pain (seldom severe) which attends the completion of the section. The conjunctival flap is replaced *in situ* to see whether the iris is in position or not. If it is, and if there is no bulging of its base into the wound, the eye is at once closed. It sometimes happens that the iris bulges into the section the moment the

disc is cut through; if so, it is snipped with scissors to let the aqueous fluid escape, and it then often goes back of itself. If it does not, then an iridectomy is performed. As a rule, a very small and peripheral section of the membrane suffices; more rarely it is necessary to make the iridectomy complete. We instil eserine drops into the eye after operation, if for any reason we fear a prolapse may take place. As a rule, no drops whatever are used immediately after the operation. We have used a Bowman's trephine throughout in Madras, and are still wavering between one of 2 mm. diameter and one of 2.5 mm."

Elliot also emphasizes the following: "(1) It is possible by using the points of the scissors, and dissecting concentrically with the cornea, to get very close to the limbus. In doing so, one must keep the points directed *towards the plane of the posterior pole of the lens;* one must not dissect tangentially to the eye. If one does the latter, one will quickly button-hole one's flap; if the former, one undermines the limbus and makes a deep groove overhung by the latter. It is the making of this overhung groove which determines that one enters the chamber with the trephine with certainty.

(2) If the trephine used is a sharp one, one can quickly, easily and certainly cut out a clean disc every time, with the reservation that in a large number of cases the disc remains attached at one small point, where the uncut tissue acts like a hinge; one clean snip of the scissors severs this, leaving a clean cut circular hole with no ragged edges whatever. I have recently made a point of pressing a little more on the corneal than on the scleral edge of the disc I am trephining, so as to make sure of entering the chamber as far forward as possible.

(3) If a clean disc is thus cut out, without undue pressure of the trephine, one comparatively seldom requires to interfere much with the iris."

Verhoeff's Sclerostome.

Within the past few months, Verhoeff[80] has devised a new instrument, the *sclerostome* (see Fig. 558), for producing a subconjunctival fistula, hoping to obviate by its use the trauma to the tissues which he has observed after the Lagrange operation. His experience with the operation thus far has been limited to two blind painful glaucomatous eyes, but the results sufficed to show that the opening made by the instrument remained patent and was effective in lowering the tension.

Transfixio Iridis of Fuchs.

In secondary glaucoma with protrusion of the iris due to annular posterior synechia, when iridectomy is contra-indicated on account of the friability of the tissue of the iris and the danger of hemorrhage and recurring iritis, Fuchs[81] recommends the following procedure:

"After local anesthesia and the introduction of a speculum, a medium sized Graefe knife is introduced 1 to 2 mm. within the temporal limbus in the horizontal meridian of the cornea. The blade is inserted parallel with the surface of the iris and is then passed through the anterior chamber and counter-puncture made at a symmetrically opposite point. The iris being driven forward is pierced by the knife as it traverses the chamber and holes made in it both temporally and nasally. These holes remain open and the communication between the chambers being restored, the intraocular pressure becomes normal and the iris returns to its normal position. After the

[80]Verhoeff. A New Instrument. (Sclerostome) for Producing a Subconjunctival Fistula. *The Ophthalmoscope*, March, 1910, p. 188.

[81]Fuchs. Ueber Transfixation der Iris. *Bericht der Ophthalm. Gessel.*, 1896, p. 179.

eye has become quiet, it is usually advisable to follow with an iridectomy, which can now be performed without difficulty on account of the lessened tension."

Operations which have for their Object the Induction of Drainage Through the Choroid and Perichoroidal Spaces.

Hancock[82] being of the opinion that the ciliary muscle in glaucoma is either in a state of spasm or atrophy, as a consequence of which the loss in elasticity impeded the circulation through the vessels of the choroid and thus favored increase of tension, sought to remove the obstacle to the vascular flow by dividing the ciliary muscle. With this end in view, he introduced a Beers' knife through the sclero-corneal junction at the lower outer margin of the cornea, the point of the knife being directed obliquely backwards and downwards until the fibres of the sclerotic were divided for more than an eighth of an inch. Ball[83] has had good results from this procedure for the relief of pain in absolute glaucoma.

Walker's Operation.

Hancock's operation was modified by Walker by what was termed *hyposcleral cyclotomy.*[84] In this procedure a very narrow knife is passed through the clear cornea, close to the margin, with the edge turned away from the centre. It is then thrust forward through the base of the iris, care being taken to avoid injury of the lens. The knife is then slowly withdrawn, incising the sclera, which imparts to the hand the sensation of cutting through gristle. This operation differs from Hancock's sclerocyclotomy in that Hancock's is through the sclera, which is cut for about ⅛ of an inch in the danger zone, whereas, in hyposcleral cyclotomy, the knife passes through cornea and iris, and the ciliary body is divided as it lies against the sclerotic. Mr. Walker has recently written the Editor of this *System* that hyposcleral cyclotomy is still his operation of choice for glaucoma.

Sclero-Choriotomy.

An operation somewhat similar to the foregoing is practised by Querenghi[85] under the name of *sclero-choriotomy,* the object being to incise the eye in such a way that the ciliary muscle will be divided at its attachment to the sclera, thereby opening up a passage between the supra-choroidal space and the anterior chamber. Querenghi considered

---

[82]Hancock. *R. L. Hosp. Reports*, 1860, Vol. III, p. 13.

[83]Ball. *Ophthalmic Year Book*, 1908, p. 193.

[84]Walker. Acute glaucoma of four weeks' duration, treated by cyclotomy; recovery of good vision. *Trans. Ophthalm. Soc. U. K.*, 1884, p. 101.

[85]Querenghi. Faits et Raisons qui Expliquent L'action De la Scléro-Iridectomie et des Autres Operations Succédanées (Sclerotomie et Incision de L'Angle Irido-Cornéen) Dans le Traitment Du Glaucome. *Annal. d'Oculist.*, June, 1900, p. 441. Same July, 1901. Encore du glaucome et de son opérabilité sans l'iridectomie.

that glaucoma depends upon the lack of communication between these two spaces. The operation is performed by thrusting a needle with a lance-shaped point or a narrow Graefe knife through the sclera 2 mm. from the limbus into the posterior chamber. The handle of the knife is now depressed and the blade pushed forward so that it glides along the outer wall of the chamber, the cutting edge being turned toward the ciliary body. After the knife has been advanced into the chamber to the extent of 5 or 6 mm., the choroid is incised from within outwards, down to the sclerotic, by short sawing movements, care being taken not to enlarge the site of puncture, to avoid prolapse of iris. Querenghi has treated 43 cases of acute and chronic glaucoma by sclero-choriotomy with a good result in 40.

Cyclodialysis.

Heine's operation[86] of *cyclo-dialysis,* which bears some relationship to the foregoing inasmuch as it is based upon the desirability of establishing a communication between the anterior chamber and the supra-choroidal space, was suggested to its originator by Fuchs' observation on detachment of the choroid in eyes after iridectomy or cataract extraction and the hypothesis of Axenfeld that such detachment may have an important bearing on the method of cure after successful operations for glaucoma.

After local anesthesia and the introduction of a speculum, the patient is told to look upward, and the globe being fixed with forceps, an incision is made through the conjunctiva with scissors, about 5 mm. from the limbus, in its lower and outer portion. The flaps of the conjunctival wound are somewhat undermined and the sclera exposed by causing the wound to gap by traction with two double tenacula held by an assistant. An incision 2 mm. long is now made through the sclera with a lancet or with the lateral edge of a small keratome held vertically at a distance of 5 mm. from the limbus and parallel to it (see Fig. 560). The incision should be made with caution, to avoid injury to the sublying ciliary body, the tissues of the sclera being divided layer by layer until the black of the uvea appears in the wound. A small spatula is now introduced into the wound and pushed slowly forwards between the sclera and ciliary body, with its plane parallel to both, until the tip appears in the angle of the chamber. (See Fig. 561.) As soon as this is accomplished, the handle of the instrument is deflected to the right and left, thereby widening the incision in the angle of the chamber and detaching the ciliary muscle from the sclera to as great an extent as possible, care being exercised to avoid injury of the lens

[86]Heine. *Deutsch. Med. Woch.*, 1905, N. 21; *Bericht der. Ophth. Gesell.* 1905; *Münch. Med. Woch.*, 1906, N. 2.

or iris with the point of the spatula. (See Fig. 562.) The spatula is now withdrawn, the conjunctiva sutured and the eye bandaged.

Care must be exercised in making the incision to avoid injuring the anterior ciliary veins, not only upon account of obscuring the field of operation, but also to obviate blood entering the chamber after the introduction of the spatula. Adrenaline will usually control any bleeding from small scleral vessels, though it may be necessary to resort to the thermocautery to stop severe hemorrhage from a ciliary vein.

The *complications* during the operation consist in too deep an incision, causing prolapse of vitreous. This is prevented by keeping the incision the same depth in the entire length of the wound and discontinuing it the moment the uvea appears. Instead of entering the cham-

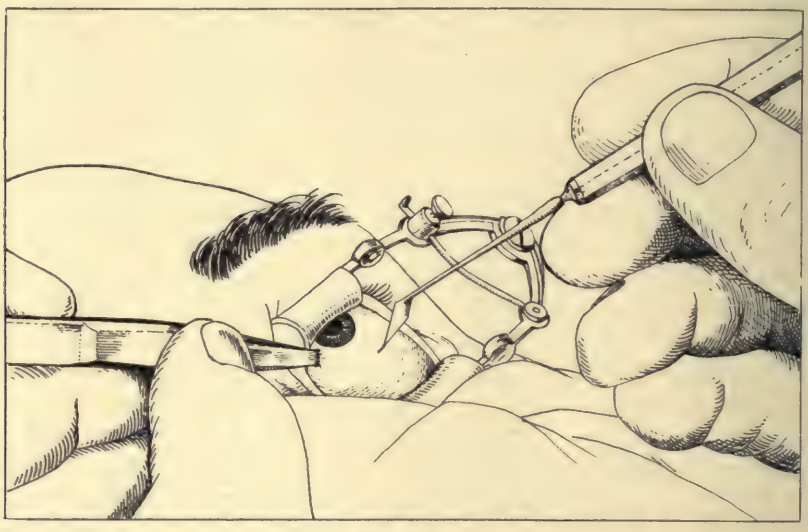


Fig. 560.

Cyclodialysis In the Left Eye. The eyelids in this operation are held apart by a spring-speculum. After the conjunctiva has been incised and the sclera exposed to view, a short incision is made with the lancet (keratome) parallel to the limbus and at a distance of about 5 mm. to the outer and lower side of it. The lancet is made to cut with its side and not with its point. (After Meller.)

ber, the spatula may be pushed forward into the cornea, detaching Descemet's membrane from the *substantia propria*. This accident should be recognized by a sensation of resistance, when the instrument must be withdrawn and further attempts made to enter the chamber by gently raising the handle of the spatula.

The *tension* as a rule after this operation does not fall for some hours afterwards and does not attain its lowest degree until one to three days later. Meller[87] has found three kinds of cases may be dis-

[87] Meller. *Ophthalmic Operations*, p. 203.

tinguished according to the condition of the eye after the operation:—those in which (1) the tension is reduced permanently; (2) the diminution is only temporary; (3) tension is wholly unaffected. In the first class (about 30 per cent.) tension sinks gradually during the first three days; indeed it may be even subnormal. The previously hazy cornea becomes clear, the anterior chamber deeper, though still shallower than normal, the pupil a little less dilated than before. The eye may remain in this condition permanently. In about 40 per cent. the diminution of the tension is only temporary and an increase returns within a few weeks; in about 35 per cent. the operation has no effect at all on the glaucoma. This is especially the case in glaucoma absolutum.

Wernicke, drawing his deductions from 76 operations performed upon 61 patients in Uhthoff's clinic, believes that on account of the dangers of iridectomy, i. e., intraocular hemorrhage from the sudden

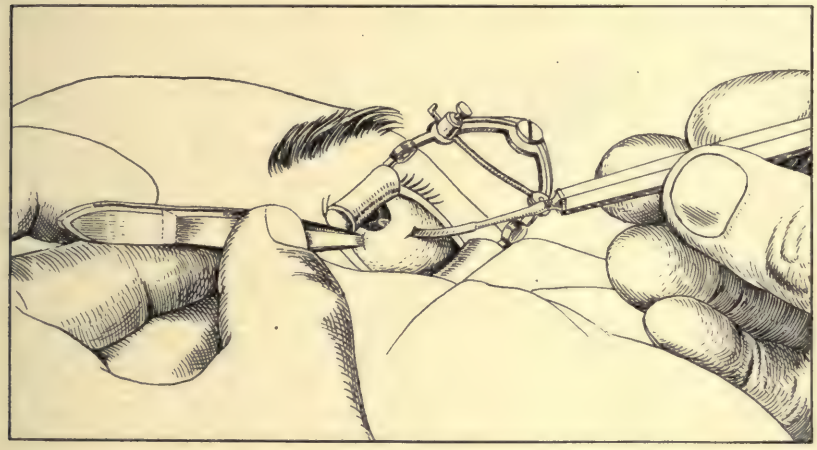


Fig. 561.

Cyclodialysis. The spatula, held parallel with the surface of the sclera and the ciliary body, and appears in the angle of the chamber. (After Meller.)

reduction in intraocular tension, injury to the lens, and the non-closure of the wound, cyclodialysis is to be preferred to the classic operation in many cases, and is equally valuable in others. In the cases above referred to, the operation improved the condition as long as the cases were under observation (20 after a period of 2 years) in 57 per cent., while there was temporary improvement in 25 per cent. Only 9 per cent. showed no improvement.

Arnold Knapp reported a series of 18 cases upon which he had performed this operation, and while he does not think it can in any way replace iridectomy, he concluded that cyclodialysis is of value in certain limited conditions. He found it indicated in the advanced cases

of chronic glaucoma, especially those in which iridectomy had not succeeded in reducing tension.

It seems to be the conviction of many conservative operators who have employed this procedure in a sufficient number of cases to warrant reliable deductions, that, while it may for a time lower tension, this effect is not permanent, and the procedure in their opinion has not proven itself to be of equal value with iridectomy or with any other of its recent modifications.

Posterior Sclerotomy.

Although de Wecker is authority for the statement that Guérin practised puncture of the sclera and cornea for the relief of increased pressure within the eye as early as 1769[88], William Mackenzie, of Glasgow, in 1830, was probably the first British surgeon who tapped the posterior segment of the eyeball upon account of increased hardness.

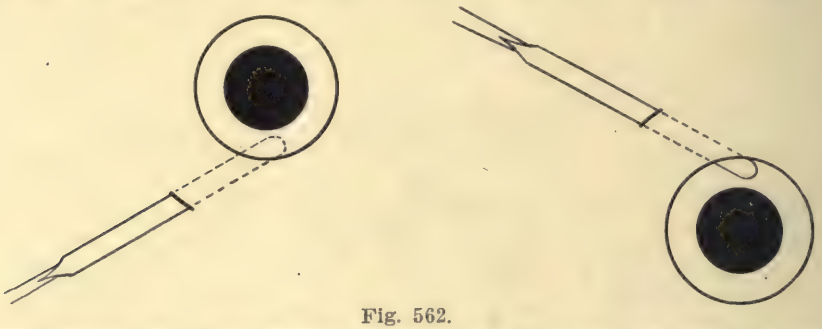


Fig. 562.

Cyclodialysis. Figure showing the position of the spatula during the performance of the lateral movement intended to detach the ciliary body. (After Meller.)

This distinguished investigator advised scleral puncture for hydrophthalmus and glaucoma, and in some cases obtained, to use his own words, "a transient amelioration of vision as well as relief from pain,"[89] the incision being made with a lance knife at the site of the old operation for depression of cataract. The instrument was then thrust backwards towards the centre of the vitreous and rotated somewhat about its axis and allowed to remain in position from one to two minutes until sufficient of the ocular fluids had escaped.

Although practised to some extent by Middlemore in 1835, the operation fell into disuse for the relief of the diseases to which Mackenzie had applied in until 1872, when de Luca[90], without apparently be-

[88]de Wecker, Schmidt-Rimpler, *Graefe-Saemisch Handbuch, der ges. Augenheilk.*, 2nd Edition, p. 187.

[89]Mackenzie. *A Practical Treatise on the Disease of the Eye*, 4th Edition, 1854, p. 899.

[90]de Luca, *Ann. di. Ottalm.*, 1872, II, p. 155; *Ann. di. Ottalm.*, 1876, IV, p. 217.

ing cognizant of Mackenzie's work, recommended it in glaucoma, not only for the relief of pain in blind eyes, but also in those which still possessed useful vision. Since that time the procedure has been frequently practised with various modifications and is now a well-recognized means of temporarily reducing tension in any form of glaucoma.

Technique. After cocainization, the lids are separated by an assistant, the patient is instructed to look upwards and inwards, and the globe is grasped near the limbus with fixation forceps. A Graefe knife is then inserted midway between the tendons of the exterior and inferior rectus muscles at a point at least 15 mm. behind the limbus, which seems to be free from conjunctival or episcleral vessels. The point of the knife is inserted perpendicular to the centre of the globe and is permitted to enter the eye to a depth of 5 or 6 mm. If the effect of a simple paracentesis is alone desired, the knife is withdrawn and the wound permitted to close.

Usually, however, it is found desirable to augment the effect of the operation by still further incising the sclera. This is accomplished with gentle sawing movements of the knife with its edge directed forwards until a meridianal incision is made, i. e., one running from behind forward, some 5 or 6 mm. in length. Care should be taken to avoid injury to the lens or ciliary body. When the incision has attained the desired length, the knife is turned slightly about its axis and the subretinal fluid with usually a bead of vitreous, escapes under the conjunctiva as is immediately made evident by a ballooning out of the conjunctiva. The knife is then withdrawn and a bandage applied. A free escape of fluid is met with, both in acute inflammatory and in chronic non-inflammatory cases. If yellow fluid presents, it indicates in all probability an earlier hemorrhage into the vitreous. External bleeding from the wound is usually but slight and can be disregarded. Perfect asepsis will prevent the septic infiltration of the vitreous which has followed the puncture in a few instances.

Motais[91] has shown that, unless the capsule of Tenon is opened by the knife, but a small quantity of fluid escapes. He insists, therefore, that the incision must lie behind the insertion of the rectus muscles, and inserts the knife rather in front of the equator well away from the venæ vorticosæ, midway between the superior and external recti. A simple rotation of the knife around its axis before withdrawal will make an L- or T-shaped incision, resembling that of a leech bite, and will insure a leakage of the wound for some days afterwards; the tension will be kept down for at least two or three days. Motais[92] fol-

[91] Motais. *Annal. d'Ocul.*, 1887, XCVII, p. 251.

[92] Motais. De la Sclerotomie postérieure, son Procédé Rationnel ses Resultats, ses Indications. *Annal, d'Oculist.*, 1901, p. 41.

lows the operation by massage of the eye for 5 minutes at a time every 2 or 3 hours for a fortnight or more after the puncture, as he claims by this means to retard the cicatrization of the wound and preserve its filtration without harm to the patient. If a second puncture is deemed desirable, he avoids the site of the previous incision.

Motais has found posterior sclerotomy of advantage in the following conditions:—absolute glaucoma, to relieve pain and obviate enucleation; in acute glaucoma, where iridectomy and anterior sclerotomy have not assisted the process (in one of his cases he preserved vision for nearly two years by this method); preparatory to iridectomy. He claims to be the first to call attention to the value of posterior sclerotomy, (1) in prodromal glaucoma, in which he thinks no other form of operation can take its place, (2) in chronic secondary glaucoma, (3) in acute secondary glaucoma. He thinks the action of the sclerotomy remarkable in this latter class of cases on account of its rapidity and efficacy.

Tobler[93] of Basel has shown experimentally that the risk of hemorrhage is much greater if the incision is made in the equatorial plane instead of in a meridional one, for not only is the direction of most of the scleral fibres in the latter plane, and hence such sections gape the least, but with the incision in this direction, only a few choroidal vessels are encountered and there is less danger of hemorrhage. Meller has demonstrated that the wound after posterior sclerotomy becomes solidly cicatrized in a few months.

T-Shaped Sclerotomy.

When a filtering cicatrix is desired, as, for example, after iridectomy and anterior sclerotomy have proved of no avail, as in absolute and hemorrhagic glaucoma, Parinaud[94] also recommended the rotation of the knife in the wound, thereby making a T-shaped incision. Claiming that this form of incision was necessary for the persistence of filtration, he asserted that his best results were obtained in cases where there was but little escape of fluid directly after the puncture, and the tension did not begin to diminish until a day or so after the operation. He, too, thought massage useful and insisted on its continuence for a long time after the procedure.

Small Equatorial Sclerotomy.

Masselon[95] formerly favored a long meridional incision of the sclera alone, in order to avoid injury to the deeper portion of the vitre-

---

[93]Tobler. *Arch. f. Augenh*, 1899, XXXVIII, I., p. 93.
[94]Parinaud. *Arch. d'Ophtalm.*, 1885, V, p. 180.
[95]Masselon. De la Sclerotomie Equatoriale. *Annal. d'Oculist.*, 1888, p. 226. Masselon. Sur. le Glaucome. *Annal. d'Oculist.*, 1886, p. 231.

ous and made a flat puncture and counter-puncture; later, however, he performed a very small equatorial incision.

Simi[96] favored 4 mm. long equatorial incisions through the sclera, without, however, injuring the choroid, as a precursor to iridectomy in cases of inflammatory glaucoma with obliteration of the anterior chamber.

In 1886, Galezowski[97] performed what he termed *sclero choriotomy, (q. v.) though in reality the procedure was a post-sclerotomy* for the relief of glaucoma simplex, hydrophthalmus and profuse vitreous hemorrhages. A Graefe knife was introduced between the superior and external rectus muscles posteriorly into the sclera, choroid and retina, the incision being prolonged anteriorly to the ciliary region. Two years later[98] he devised a peculiarly shaped knife by means of which two incisions were made through the sclera only as far posterior as possible. This procedure was especially applicable to cases of glaucoma simplex.

In 1894, Priestley Smith[99] advocated puncture of the sclera as an adjunct to iridectomy in the treatment of glaucoma and has recently written the Editor that a continued experience still confirms the value and safety of his procedure.

The *sclera was trephined for absolute glaucoma* by Argyll-Robertson[100], but with only partial success, and the procedure was soon abandoned. Recently, however, Fröhlich[101] recommends the removal of a piece of the sclera in preference to enucleation, or one of its substitutes, in blind glaucomatous eyes. He performs the operation as follows: Incisions in the conjunctiva 10 to 12 mm. long are made parallel to the lower edge of the external rectus to the outer edge of the inferior rectus, and the flap of conjunctiva between these incisions is turned back. Von Hippel's trephine with the 5 mm. crown is applied to the sclera back of the ciliary body, and so adjusted that a disc will be cut from the sclera without injuring the choroid. Otherwise intraocular hemorrhage would occur and render the operation unsuccessful. The vitreous breaks through the retina and choroid, lowering the tension, the conjunctival flap is sutured in place and the tension remains subnormal. In four cases reported, one irritative, one hemorrhagic, and

---

[96]Simi. Puntura della Sclerotica nel Glaucoma. *Bollettino d'Oculist.*, 1887, IX, p. 17.

[97]Galezowski. De l'ophtalmotomie ou sclerochoriotomie posterieure. *Bulletin Mem. franc. d'Ophtalm.*, 1886, p. 256.

[98]Heidelberg Congress, 1888, p. 282.

[99]P. Smith. *Trans. of 8th Internat. Ophth. Cong.*, Edinburg, Aug., 1894, p. 33.

[100]Robertson. Trephining the Sclerotic—A New Operation for Glaucoma. *Royal Lond. Hospital Reports*, Vol. VIII, p. 404.

[101]Fröhlich. Ueber die Trepanation der Sklera bei schmerzhafter Glaukom-Blindheit. *Klin. Monatsbl. f. Augenheilk.*, 1904, p. 411.

two secondary glaucoma, the results were favorable. In a fifth case the operation was a failure. The author, while unwilling to recommend this procedure unconditionally, thinks it ought to have a better reputation than it now possesses.

Indications for Posterior Sclerotomy in Glaucoma.

As has just been shown, posterior sclerotomy is admirably adapted to effect a normal or almost normal depth of the anterior chamber in all forms of glaucoma, and may safely precede iridectomy when this procedure is rendered ineffective by the presence of a very shallow chamber. It may also be employed to temporarily reduce tension in inflammatory glaucoma when, for any reason, such, for example, as septic conditions of the eye, or from the immediate risk of an anesthetic, iridectomy must be postponed. The puncture holds the glaucoma in abeyance until the septic condition has been removed, or, until the decrease in the inflammatory symptoms with which it is followed does away with the necessity of a general anesthetic and permits of the use of cocaine. In hydrophthalmus it is the writer's operation of choice. It is also often of service in absolute glaucoma with pain, when other operations have been of but little avail and the patient refuses enucleation. While advised and practised by some in cases of non-congestive glaucoma when the vision has been almost entirely lost, the writer believes sclerotomy is contra-indicated on account of the danger of annihilating the little vision that remains, as a consequence of the intraocular hemorrhage which may follow the procedure. The persistent use of miotics even in these desperate cases affords the best means of conserving vision.

EXCISION OF THE SUPERIOR CERVICAL GANGLION.

In the symposium on the relation of the cervical sympathetic to the eye, which was held in the Section on Ophthalmology of the American Medical Association in New Orleans in May, 1903, de Schweinitz, in a paper on the *Physiology of the Sympathetic in Relation to the Eye*, said: "As long ago as the time of Pourfour de Petit, that is, in 1727, it was observed that after section of the sympathetic, the eye was softer, and this fact was afterwards verified by Claude Bernard and other experimenters, and very early it was suggested that a primary disease of the sympathetic ganglia of the neck might be the basal cause of glaucoma."

The various theories which had been advanced by various observers to explain *the influence of the sympathetic on intraocular tension* were then discussed at length and the conclusions from the evidence which had been collected summarized as follows: "Electrical stimulation of the cervical sympathetic produces at first an increase and later

a decrease of intraocular tension, the increase being probably due to an effect on the muscles of the eye. Slow-acting, mechanically produced irritation of the sympathetic causes a rise of tension, which, according to Lodato, is independent of dilatation or constriction of the blood vessels, and also independent of the state of the pupil. Section of the sympathetic, or extirpation of the sympathetic ganglion, is followed by a fall of intraocular tension, which depends on vascular and, perhaps, muscular changes. The lowering of tension is more decided after excision of the ganglion than after section of the sympathetic cord, but, in either case, the effect is a temporary one, and may last more than a few days, and sometimes disappears within a few hours."

According to Grimsdale and Brewerton[102], Wegner noticed changes of the intraocular pressure in animals when the cut end of the cervical sympathetic was stimulated, a fact noted in the 12th volume of Graefe's Archives. It was not, however, until 1897 that any form of operation was proposed on the vaso-motor nerves of the eye to influence glaucoma, when Abadie[103], who ascribed the increased tension of glaucoma to a vascular disturbance, proposed to relieve the condition by the removal of the cervical sympathetic. Before he had an opportunity, Jonnesco[104] published a paper in which he reported the results of a series of operations which had been performed in pursuance of Abadie's suggestions. Both of these investigators, however, held different theories as to the cause of glaucoma, Abadie attributing it directly to an increase of exudation brought about by an active dilatation of the blood vessels, particularly the arteries, while Jonnesco asserted that the small arteries are contracted, and that the resulting increase of intra-vascular pressure occasions an increased transudation and probably an increase in the amount of aqueous humor. The dilatation of the blood vessels was thought by Abadie to be due to the activity of the vasomotor centres and he asserted that, when the chain is cut, the stimuli cease, and the blood vessels resume their normal caliber.

Jonnesco removes the superior cervical ganglion by an incision along the anterior border of the sterno-mastoid muscle, about 3 inches long, having its center opposite the angle of the jaw. The various layers of the cervical fascia are then carefully divided until the border of the muscle is exposed. The sheath of the carotid artery is then laid bare and the dissection continued between the artery and vein until the ganglion is exposed behind the former.

To avoid the risk of opening the sheath, Burghard[105] deflects it

---

[102]Grimsdale, Brewerton *Text Book of Ophthalmic Operations*, p. 312.
[103]Abadie. *Arch. d'Ophtalm.*, Vol. XIX.
[104]Jonnesco. *Centralbl. f. Chirurgie*, 1899.
[105]Burghard. *British Med. Jour.*, Oct., 1900.

inwards with a blunt hook, when the sympathetic ganglion is found just posteriorly. The ganglion is readily freed from its surroundings by careful dissection, and is excised by a few clips of the scissors, the ascending branches being divided close above the top, and the descending cord about half an inch below the ganglion. The wound is then sutured. Some operators advise exposing the ganglion by way of the posterior portion of the sterno-cleido-mastoid muscle, but, as this exposes the spinal accessory nerve to the risk of injury, the anterior route is to be preferred.

In the symposium referred to above, Wilder spoke of the influence of resection of the cervical sympathetic ganglion in glaucoma and epitomized the records of 68 operations done on 54 cases in the following table:

SUMMARY.

Form of Glaucoma.	No. of Cases.	Improved.	Temporarily Improved.	Stationary.	Unimproved.
Simple chronic	38	15	5	3	15
Chronic inflammatory	16	4	3	3	6
Subacute	4	3	1	..	..
Acute	3	1	1	1	..
Absolute	4	1	..	..	3
Hemorrhagic	2	2	..	..	..
Buphthalmus	1	..	..	..	1
	68	26	10	7	26

The results exhibited in this series of cases, at first glance, do not seem as favorable as those presented by Rohmer[106] who drew conclusions from a study of 74 cases collected by Richat, to which he added 20 of his own. On these 94 cases, 114 operations were done. The following table gives a summary of the results of their analysis of these cases:

Form of Glaucoma.	No. of Cases Operated on.	Improved.	Negative.	Worse.
Simple chronic	43	36	5	2
Chronic inflammatory	34	23	10	1
Subacute	14	6	6	2
Acute	9	4	5	..
Absolute	3	1	2	..
Hemorrhagic	5	5	..	..
Hydrophthalmus	6	4	1	1
	114	79	29	6

As a consequence of the statistics which he had gathered, Wilder thought that while positive conclusions are yet to be reached and will not be attained until more carefully selected cases can be studied for longer periods of time, he could assent to the statement of Axenfeld that "there is obtained by this operation in a certain proportion of cases

[106]Rohmer. De l' Extirpation Du Ganglion Ciliare. *Annal. D'Oculist*, July, 1902, Part. I.

of simple glaucoma, a definite and important result, and in some instances there has been a decided improvement, even where a previous iridectomy has failed."

Wilder considered the operation in itself, while a major one, is not to be regarded as one of unusual danger, and with modern technique should show a very trifling mortality. His conclusions were as follows: "The statistics up to date seem to indicate that the simple chronic form is the one most suited for it, next to the hemorrhagic form, if that can be determined. As a guide for my own practice, I should feel very much like following Abadie when he says: 'In acute forms of glaucoma and in subacute with intermissions, practise first iridectomy, and if it fails, do sympathectomy. In simple glaucoma, use miotics twice a day; if they suffice, continue them. If, in spite of their systematic employment, the vision fails, do sympathectomy.' "

During the past few years, the operation has been rarely practised, for, though sometimes successful in reducing tension, disastrous results have also occurred, and several have died from the operation. In others symptoms of tachycardia and exophthalmus have developed.[107] Its most favorable results are no better than can be attained by other and less dangerous operations on the globe itself, or from the continuous use of miotics.

REMOVAL OF THE CILIARY GANGLION.

Believing that the ciliary ganglion controls the vascularization of the anterior segment of the eye, and the superior cervical ganglion that of the posterior segment, Rohmer[108] devised an operation for the removal of the ciliary ganglia of the orbit and practised it on 7 cases of absolute glaucoma. His procedure was as follows: After a resection of the outer wall of the orbit, as recommended by Krönlein, the tissues of the orbit are exposed as directed by this operator, by dividing the periosteum and orbital fascia until the external rectus muscle is laid bare. This is divided and efforts made to remove the ciliary ganglion, which consists of a nerve mass not more than 2 mm. in its largest diameter, and lies about 15 mm. behind the posterior pole of the eye, and about 9 mm. in front of the optic foramen, between the external rectus muscle and the optic nerve, by means of a special forceps. These are a modification of the common forci-pressure forceps, one blade being grooved on its outer surface longitudinally, to permit of its being guided along the optic nerve on its outer side. Half a dozen bites of the orbital tissues are made with these forceps, a careful examination

[107] Herbst. *Thése de Paris*, 1900.

[108] Rohmer. De l'extirpation Du Ganglion Ciliare. *Annal. D'Oculist*, July, 1902, Part I.

being made of the avulsed fat and tissue after each attempt, to discern the bruised and mangled ganglion. Even if the ganglion is not found, a pallor of the conjunctiva and a fall in tension indicates its removal and the surgeon may proceed to the closure of the wound, which is accomplished as directed by Krönlein. Although Rohmer claims that the pain in the 7 cases operated upon by him was ultimately alleviated, even though tension was never reduced to normal in any, the operation has not been practised by others, indeed, Parsons believes that the results of Rohmer's work afford little support to the view that the increased intraocular tension of glaucoma is in any way associated with the ciliary ganglion.

Terrien and Poirson[109] have reported 7 cases of absolute glaucoma successfully operated on by this method, but other operators seem to have found the procedure too drastic for cases of even absolute glaucoma, and it has not yet found a place in ophthalmic surgery.

AVULSION OF THE INFRATROCHLEAR NERVE.

In 1883, Badal[110] recommended stretching of the infratrochlear branch of the nasal nerve to relieve the pain of glaucoma. It was noted that hypotonus frequently followed several weeks after this procedure, but the degree of the hypotonus was less than after iridectomy or sclerotomy, and was probably occasioned by the simultaneous avulsion of the sympathetic root of the ciliary ganglion. Abadie and Indovian[111] operated on several cases after this method, and Angelucci on 13. In all cases, a temporary decrease in pain and hyperemia and intraocular tension followed, but the symptoms reappeared after several days. The procedure has been especially recommended in glaucomatous myopic eyes in which dislocation of the lens was to be feared at the time of operation[112], also in hemorrhagic glaucoma, and finally Villemonte[113] thinks it of service in glaucoma simplex and secondary glaucoma.

---

[109]Terrien and Poirson. *Bull. de la Soc. de Chir. de Paris*, Apr., 1902.
[110]Badal. *Annales d'Oculist*, 1883, p. 84.
[111]Abadie and Indovian. *Arch. d'Ophtalm.*, II, p. 225.
[112]Cabannes and Pichot. *La Clinique Ophtal.*, 1902.
[113]Villemonte. L'Arrachement Du Nerf Nasal Externe. *Rec. d'Ophtalm.*, 1906, p. 513.

CHAPTER VIII.

EXTRACTION OF THE SENILE TYPE OF CATARACT.

By CASEY A. WOOD, M. D., Chicago.

Definition of the Term Cataract—Historical Review of Cataract Extraction—Knife for Making the Incision Through the Eyeball—Cataract Knife (Young)—Types of Extraction Methods—Must the Operable Cataract be Mature?—Shall the Operation be Undertaken on Both Eyes at One Sitting?—Condition of the Patient's Health in Cataract Extraction—Shall We Operate at a Hospital or in a Private House?—The Preoperative State of the Ocular Apparatus—Meibomian Glands and Ducts—Pre-operative Disinfection of the Operative Field—Preoperative Considerations — Preparatory Measures—A Preliminary Training — Further Preparation of the Operator and Patient—Bringing the Patient to the Operating Room—Local Anesthesia—The Illumination—The Use of a Lighted Candle as a Fixation Object for the Patient During Operations for Cataract—Position of the Operator and His Assistants—Fixing and Steadying the Eyeball—The Puncture and Counter-puncture—Advantages and Disadvantages of the Conjunctival Flap—Opening or Cutting the Capsule—Cystotomy—Expulsion of the Lens—Expulsion or Removal of Cortical Matter—Immediate Treatment of the Sclerocorneal Incision and Conjunctival Flap—Beard's Cautions—Post-operative Dressings in Cataract Extraction—Removal of the Patient to his Room—The After-treatment of Cataract Extraction—The Instruments Commonly Used in the Extraction of Cataract and a Few of their Modifications—Testing Instruments—The Speculum and Blepharostat—Fixation Instruments—The Angelucci Fixation Method—The Corneal Knife—The Iris Forceps—The Iris Scissors—Cystotome—Iris Spatula or Repositor—Instruments for Assisting in the Delivery of the Lens—Anterior Chamber Irrigator—Some Modern Variations in the Technique of and in the Instruments Employed in Cataract Extraction—Modifications of the Corneal Section—Mueller's Corneal Incision—Schulek's Incision—Extraction with a Lance-shaped Knife—Preliminary Iridectomy—Extraction with Iridotomy—Peripheral Iritomy as a Safeguard Against Prolapse of the Iris—Incisions into and Removal of the Anterior Capsule — Cystotomy — Preliminary Capsulotomy—Preliminary Rupture of the Capsule Before Making the Corneal Section—Opening the Capsule with the Cataract Knife During the Corneal Incision—Puncture of the Posterior Capsule—Immediate Posterior Capsulotomy—Capsulotomy in Opaque, Thick and Tough Capsules—Removal of a Portion of the Anterior Capsule—Extraction After Instrumental Rotation of the Lens—Delivery of the Lens—Intraocular Irrigation During Cataract Extraction

—Conjunctival Suture after Cataract Extraction—Suturing the Conjunctiva—Czermak's Subconjunctival Extraction—Subconjunctival Extraction of Cataract—After-treatment of Cataract Extraction—Some of the Accidents and Complications of Senile Cataract Extraction and Their Treatment—Reposition of the Iris that Has Fallen in Front of the Knife—The Split Cornea—Hernia of the Iris—Post-operative Iritis and Iridocyclitis—Inspection of the Operative Wound—The Later Complications of Senile Cataract Extraction, their Causes and Treatment—Post-operative Astigmatism—Colored Vision—Systemic Disturbances.

Definition.

Cataract or opacity of the crystalline lens is the result of structural changes in the cells and fibres of which it is composed. Sometimes these alterations of structure are irregularly distributed throughout the body of the lens, as in most cases of *senile cataract;* sometimes they are mainly central *(nuclear cataract)* and not infrequently they are confined to the periphery or cortex *(cortical cataract)*. There is a great variety of cataracts,[1] but the most practical division of them is into *"soft"* and *"hard"* cataracts. Speaking generally, the soft variety occurs in persons below thirty or thirty-five years of age, while the hard variety is found only in older patients.

Senile Cataract (Hard Cataract).

This is the commonest as well as the most important form of the disease, the cortical variety being most frequent.

The normal lens gradually grows larger and denser as we grow older and exhibit other senile changes; the lenticular nucleus in particular becomes firmer, and with the rest of the lens acquires a yellowish tint and transmits less light than formerly.

As a consequence of these changes cataractous lenses vary greatly in diameter—a matter of much importance in connection with the length of the incision made for their removal. It must be remembered that this diameter is rarely less than 10 mm. in the ordinary form of opaque lens.

When the pupil is widely dilated the grayish translucent outline of the whole crystalline is distinctly visible, both with the oblique illumination and by reflected light. While these alterations, attendant upon old age, may be regarded as more or less physiological, they are closely allied to true cataract. In the latter instance, however, delicate lines, or well defined streaks of opacity, best seen by reflected light with a dilated pupil, add themselves to the normal translucent gray of the lens. These commonly begin at the periphery or equator, and slowly invade both cortex and nucleus until the whole crystalline is involved.

---

[1] Wood and Woodruff. *Commoner Diseases of the Eye.* Third Ed., p. 364.

The pictures made by progressive senile cataract, from the time when the first, faint striæ appear until the cataract is complete, are often very pretty, and remind one of the geometrical shapes one sees when snow-flakes are examined with a lens.

The time occupied by the process varies greatly, but may extend over many years. Some opacities remain stationary during life.

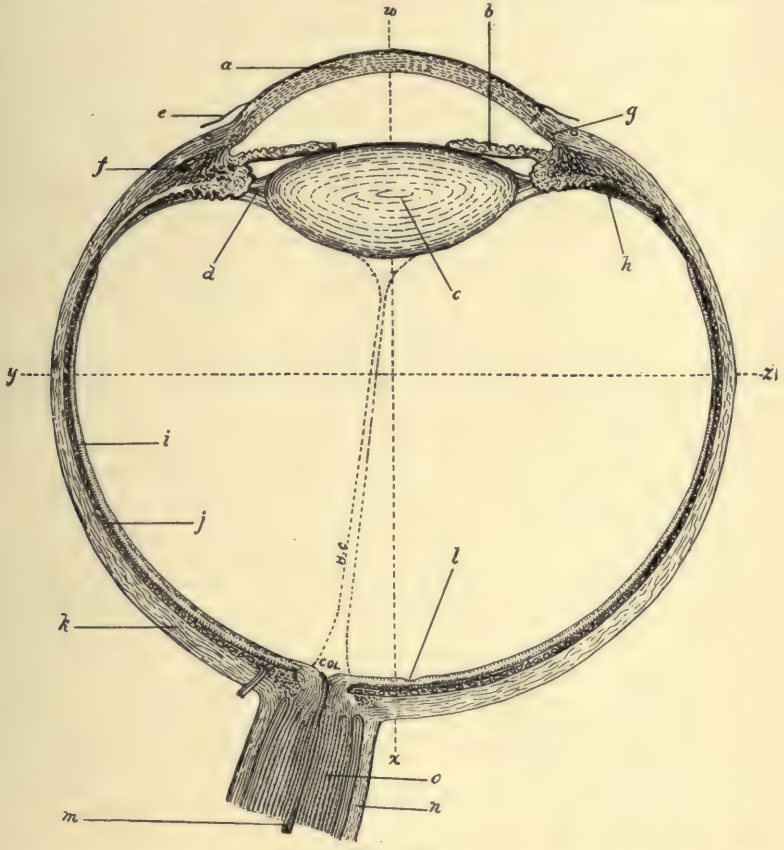


Fig. 563.

Section of the Eyeball to Show the Crystalline Lens System and Its Bulbar Relations. (After Quain).

a. Cornea.
b. Iris.
c. Lens.
d. Zonula of Zinn.
f. Ciliary body.
g. Canal of Schlemm.
h. Retina.
j. Choroid.
k. Sclera.
H, C. Hyaloid canal.
l. Macula.
o. Optic nerve.
w. Anterior capsule.

Sight will not be much affected until the nucleus (in the area of the pupil) is involved. The patient then complains that images are distorted or multiplied (polyopia), or that there is a cloud, or floating body, before the eyes. During this period (incipient stage) the sectors or streaks of opacity, when viewed through the dilated pupil, appear grayish by oblique illumination, and black with the reflected light of the ophthalmoscope, the red reflex of the fundus showing through the clear portion of the lens. The fogginess increases very slowly until finally the visual acuity is reduced to the counting of fingers. In the early stages, before the opacity has completely invaded the periphery, vision is better in a dim light, because the moderate dilation of the pupil that occurs in a partially illuminated room, for example, permits the patient to see through some, as yet unaffected peripheral parts of his lens. Occasionally a person blind in a bright light is able to read if he shades his eyes with his hand.

As the cataract advances the lens swells, becomes more convex, and the patient may be able to discard his reading glasses entirely (although the affected eye always sees worse in the distance), owing to the increased refractive power of the crystalline. He then develops the condition commonly known as *"second sight."*

When the cataract is ripe or mature the whole lens is opaque, and it can safely be removed from the capsule by operation without leaving any soft, lens matter behind. Such a cataract should have a *mother-of-pearl appearance by oblique illumination,* and while the examination is being made (the pupil undilated) the iris should not cast a shadow on the lens surface. *Shadows cast by the iris on the lens indicate that the anterior layers of the crystalline are still immature and transparent;* the shadow being thrown on the opaque nucleus. There should also be no glittering sectors or facets brought to view as the patient is told to look in different directions during the examination.

When an operation is undertaken on an immature cataract the soft, glue-like portions of the unripe lens stick to the parts in the anterior chamber, and resist ordinary attempts to remove them. These small masses not only act as foreign bodies, producing irritation and inflammation of the iris, but, transparent at first, finally become opaque, and lower the visual acuity.

In time the cataract becomes *hypermature,* or over-ripe. It may then shrink, or, becoming soft, semi-fluid, or of a milky consistency, allow the hard nucleus to sink to the bottom of the capsule cavity, showing there as a small amber-colored body *(Morgagnian cataract).* In such cases the iris loses its natural support, and an iridodonesis is the result. Sometimes the opaque lens takes on a dark-brown color.

and with oblique illumination the pupil presents a black, almost normal appearance, although the cataract is mature *(black cataract)*.

Cataract may remain stationary and unless the opacity involves the central portion of the lens, vision may be very little impaired. Even when the opacity involves the pupillary area, it may take several years for the cataract to mature, and become favorable for removal.

Risley[2] believes that the term *senile*, "which still occurs in our catalogs as a qualifying adjective, has been misleading, since it removed

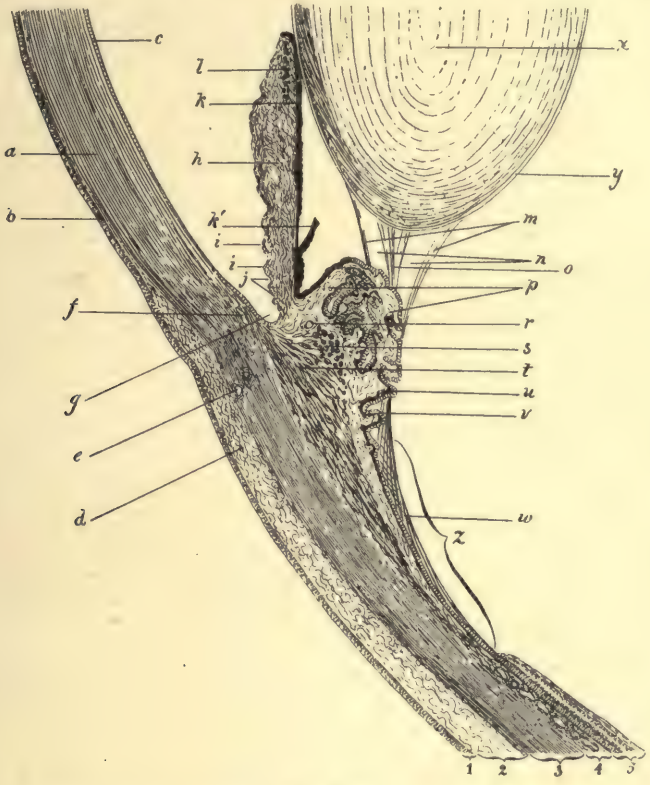


Fig. 564.

The Immediate Relations of the Crystalline Lens System. (After Quain).

a, Cornea; *f*, Canal of Schlemm; *g*, Iridic angle; *h*, Iris; *k*, Posterior pigment layers (detached); *m*, *c*, Zonular fibres; *n*, Interfibrillar spaces; *p*, *r*, *s*, *t*, Ciliary body; *1*, *2*, Conjunctiva; *3*, Sclera; *4*, Choroid; *s*, Retina.

hard cataract, in the mind of the student, from the domain of pathology, and places it, like gray hair, etc., among the signs and concomitants of advanced life; whereas opacity of the crystalline lens occurs at any age. It is soft when present in early life, partly for the reason that in infancy

---

[2]Risley. The Extraction of Cataract; Choice of Operation Based Upon Intraocular Conditions. *American Medicine*, Feb. 18, 1905, p. 273.

and youth the normal lens is relatively soft, it is hard in old age, because even the transparent lens in advanced life is relatively hard. In the hard cataracts of middle and advanced life we should also regard them as the result of antecedent pathologic states of the fundus oculi. Such a view would not only modify our prognosis in many cases, but change our procedure in many important respects. For example, if asthenopic symptoms are still present, we would not hasten our operative procedure, not because of immaturity of the cataract, but for the reason that the choroid behind the opaque lens is still in a pathologic state, the judicious treatment of which for a few weeks or months would materially improve the prognosis as to a favorable result from extraction. It is probable that in this view of the nature and cause of the opaque lens we find a sufficient explanation for the proverbially bad results following attempts at extraction of immature hard cataracts after 55 years or 60 years of age; or, on the other hand, for the more favorable prognosis entertained in cases of fully 'ripe' lenses."

The extraction of the senile type of cataract is probably the most important operation the ophthalmic surgeon is called upon to do, and while in the average case the result is satisfactory yet that task, surrounded by many difficulties and chances of disaster, should never be lightly undertaken. It is at least due to the patient that the operator —especially the practitioner with slight experience—should carefully review before each operation the technique and have an *organic knowledge* of the usual accidents and other complications that may precede, accompany or follow the attempt to remove this obstruction to vision.

While it is chiefly by practice on the living human subject that one becomes most expert in the delicate manipulations that constitute a deftly performed extraction, yet a great deal may be learned from a carefully worded description of it. In the following pages it is intended to carry the student along, *pari passu*, by considering not only the manipulations and instrumentations in their regular order but to set down—at the time and place they generally occur—those deviations from the straight path of normal cataract extraction that every well-informed operator should bear in mind.

It is not to be supposed that it will ever be possible for ophthalmic surgeons to agree upon a universal method of lenticular extraction; indeed, there is a constant tendency to vary not only every step of the original operation but every step of the operations now performed by the best known surgeons. The earnest ophthalmologist eagerly embraces every chance to perfect his own *technique*, as well as to increase the value of the operation in the hands of others. Yet the personal equation that, sensibly or insensibly, governs the choice of methods in other departments of human endeavor will continue to dominate the selection of ways and means in cataract removal. If we have the chance of comparison we generally choose those instruments and adopt those methods that appear to suit best our peculiar manipulative skill—or the lack of it. Moreover, the surgeon who has mechanical ability is very likely to make in one or more existing instruments or

methods such modifications as appear to him (and may or may not appear to his fellows) to be improvements.

These rules are especially true of the extraction of cataract and as that procedure is a rather complicated one, it is particularly subject to variations in instrumentation and technique.

Historical Review of Cataract Extraction.

The palm for the discovery of the extraction of cataract through an opening in the eyeball is very properly awarded to Daviel. That surgeon had, however, a number of forerunners.

Both Antyllus and Galen, as well as surgeons of the Arabian school of ophthalmology, speak of the operation upon so-called cataract through an opening into the anterior chamber, but there can be no doubt that this had reference to the drainage of *hypopyon*—the so-called fluid *hypochymata.*

Maître-Jean[3] and Brisseau[4] in the beginning of the eighteenth century for the first time correctly interpreted the conditions underlying ordinary cataract.

These discoveries were further elaborated by H. Freytag[5] and Blancard.[6]

Freytag describes the operation which he performed several times, but always on dislocated lenses, during 1692 to 1698. He made a very small opening in the cornea with a knife-needle and endeavored to withdraw the cataract through the perforation by means of a hook.

Blancard did not actually do an extraction but described an operation which he believed might be done.

St. Yves[7] was probably the first to make a sufficiently large opening in the cornea and through it to extract the lens, but this operation, again, was done on a cataract dislocated into the anterior chamber. During the year 1707 he extracted two such lenses in the presence and under the direction of Méry. In exactly the same way Pourfour du Petit,[8] in 1708, also on the advice of Méry, removed a lens dislocated into the anterior chamber.

In 1745 Daviel, while endeavoring to perform an operation such as Petit had done some years before upon a portion of a cataract that had found its way into the anterior chamber, having made the first part of the Petit operation, enlarged the opening with scissors and

[3]Maître-Jean. Traité des maladies de l'oeil et des remèdes propres pour leur guérison Troyes, 1707.

[4]Brisseau. Traité de la cataracte et du glaucoma, Paris, 1709.

[5]Freytag. De cataracta. *Inaug. Diss. Argentorat*, 1721, p. 74.

[6]Blancard. *Neue Kunstkammer der Chirurgie*, 1688. Translation from the Dutch. A further account is given in *Opera Medica Theoretica Practica et Chirurgica.* Lugd. Batav., 1701.

[7]St. Yves. *Mémoires de L'Académie Royale de Chirurgie*, 1707.

[8]P. du Petit. *Mémoires de L'Académie Royale de Chirurgie*, 1708.

removed the whole body of the lens by means of a spatula which he introduced through the pupil and with it brought the lens into the anterior chamber and then out of the eye. This operation, performed upon a woman, was followed by good visual results. Then followed four other cases in which the lens was successfully removed entire in its capsule. After that experience he had a number of cases that did not turn out so well—a result which he thought was due to defects in his technique; he failed to incise the capsule sufficiently or to make the opening in the cornea sufficiently large. In the year 1750, however, he decided to remove all cataracts by this method. There can be no doubt, therefore, that to Daviel belongs the honor of the discovery and invention of the modern method of cataract extraction. It may further be stated that we have not in any essential degree improved upon the original discovery. It is true that we have added to it those inestimable boons, local anesthesia, asepsis and antisepsis, but the technique of the favorite form of extraction has not essentially changed in 150 years.

When Daviel,[9] on the 13th of April, 1752, published his first celebrated communication to the *Académie Royale,* he had already performed 200 operations. He made an opening[10] first into the anterior chamber at the lower margin of the cornea, using for the purpose a sharp-pointed, lance-like knife very much like our ordinary keratome. This opening was then enlarged on both sides with a blunt-pointed, double-edged knife and, when necessary, the incision was further continued with delicate scissors so curved on the flat as to follow the sclero-corneal circle. The whole incision corresponded to the limbus and involved about one-half the corneal circumference. These scissors were made both right and left, the blade introduced into the anterior chamber being blunt-pointed. The corneal flap was, after completion of the incision, gently raised with a small spatula (still known as Daviel's spoon) and the lens incised with a sharp needle.

The delivery of the lens followed by means of pressure upon the lower margin of the wound with the first and second finger tips placed upon the lower lid. When the anterior capsule was found to be thickened a complete disc was cut out of it and removed from the interior of the eye. The flap was then allowed to fall into place. It is quite easy to follow the various steps of the Daviel operation from the illustrations that appear with his original paper. For a reproduction of these cuts see Frank's Chapter.

---

[9]Daviel. Sur une nouvelle Methode de guérir la cataracte par l'extraction.. *Mémoires de l'Académie Royale de Chirurgie,* Vol. 2, 1753, p. 337.

[10]I am indebted to A. A. Hubbell's biographical sketch of Samuel Sharp, not only for an interesting account of that surgeon's original work but for several illustrations, reproduced from the *Medical Library and Historical Journal,* 1904, in which he published his interesting memoir.

In spite of this great improvement in dealing with cataract extraction the old operation of couching or reclination died hard. Pott, in England, and Scarpa, in Italy, not to mention Buchhorn, Lengenbeck, Dupuytren and others, continued to do the latter operation in preference, but eventually Sharp, Wenzel, Wathen, Warner, Tenon, Pamard, Richter, Thos. Young, Beer and others, who had taken up the cudgels for the new procedure, made it the established method of extraction.

The *technique* of cataract extraction was further improved by the introduction of artificial mydriasis, first employed for that purpose by Himly.[11]

In 1753 Samuel Sharp,[12] in endeavoring to improve upon the method of Daviel, made use of a knife in cataract extraction which (see the figure) was straight on its flat surface but somewhat convex on its back. It was slightly concave on its edge, little less than an inch long and at its heel about one-eighth to one-sixteenth of an inch wide, gradually tapering to a fine point.

According to Hubbell, Sharp first used his knives on April 7, 1753, but before June 11, 1753, when de la Faye first employed his on the living subject, he had made seven extractions with it. Previous to Sharp's first operation *no other surgeon had used a single knife in making the corneal section.* We may, therefore, accord to Sharp the honor of first using a knife alone.

From Sharp's first paper[13] we take the following description of his operation:

"Place the patient in the same situation as for couching, either opening the eyelids with your forefinger and thumb, or letting an assistant raise the upper eyelid, whilst you yourself keep down the under eyelid. Then, with a small knife (see the figure), holding its edge downwards, make a puncture through the cornea near its circumference into the anterior chamber of the eye, in such a direction as to carry it horizontally, and opposite to the transverse diameter of the pupil, after which you are to pass it towards the nose, through the cornea from within outwards, as near to its circumference, as in the first puncture.

When you have made the second puncture, push the extremity of the blade one-seventh of an inch beyond the surface of the cornea, and immediately cut the cornea downwards, drawing the knife towards you as you make the incision. After this, you press gently with your thumb against the inferior part of the globe of the eye, in order to expel the cataract [in its unruptured capsule, W.] and the operation finishes, according to the different circumstances, as in the manner proposed by Mons. Daviel.

One extraordinary benefit seems to arise from the use of this single instrument, and perhaps from the shape of its blade, which increases in

[11]Himly. *Ophthalmologische Beobachtungen und Untersuchungen.* First Part. Bremen, 1801.

[12]Sharp. *A Critical Enquiry Into the Present State of Surgery.* London, 1754, p. 252. I am indebted to Hubbell's paper, just referred to, for the figures picturing Sharp's various knives.

[13]*Philosoph. Trans.*, London, 1853, Vol. 48, pt. 1, p. 327. Quoted from Hubbell, *loco cit.*

breadth all the way towards the handle; for, by this means, the punctures are so exactly filled up by the blade that very little of the aqueous humor is discharged before you begin to make the incision, and consequently during this time the cornea preserves its convexity; whereas by using one instrument to puncture, and others to dilate, the cornea immediately becomes flaccid, upon the issue of the aqueous humor, and renders the operation tedious and embarrassing, as I myself have found by experience in one patient, on whom I performed the incision of the cornea with a pair of scissors, as recommended by Mons. Daviel."

Knife for Making the Incision Through the Eyeball.

As is well known, Daviel (April 13, 1752) opened the eyeball along the lower margin of the cornea with a curved, lance-like knife. As indicated by Hubbell,[14] Georges de la Faye was the first (Nov. 11, 1752) *to suggest a single knife* with which to make the corneal incision, but Samuel Sharp, of London, was the first to put such an instrument to actual use on the living subject (April 7, 1753). From that time henceforward the single knife, modified in different ways by Poyet, of Paris (1753), Joseph Warner of London (1754), Louis Béranger, of Bordeaux (1756), Jacques Réné Tenon, of Paris (1757), Pierre-François-Benezet Pamard, of Avignon (1759), and by others in rapid succession, soon became a powerful rival of Daviel's knives and scissors, and finally, long before the end of the 18th century, it superseded them entirely.

Sharp not only exhibited and demonstrated his instrument in England but, during the summer of 1753, sent one to his friend Morand, at that time Secretary of the *Académie Royale de Chirurgie*, who showed it to Parisian surgeons and inserted a cut of it (together with the proposed knife of de la Faye) in the *Mémoires*.

The complications following the Daviel operation were probably the main reason for the *abandonment of several instruments* (in making the corneal incision) for the use of the single knife.

I have already referred to Sharp as being the original inventor of the single-instrument method of opening the cornea. This discovery was soon followed by the knife of de la Faye[15] that closely resembled the Sharp instrument.

Cataract Knife (Young).

We are indebted to A. A. Hubbell[16] for a description of the knife used by Thomas Young. As will be seen in Fig. 566, it had a blade 4 cm. (about one and a half inches) long, 5 mm. (about two and a half

[14]Hubbell. A Cataract Knife of Excellent Shape and Proportion Devised a Century and a Half Ago, by Dr. Thomas Young, of Edinburgh, and the Knives which Preceded It. *Ophthalmic Record*, Nov., 1900, p. 547.

[15]de la Faye. Mémoire pour servir á perfectionner la nouvelle Méthodé de faire l'operation de la cataracte. *Mém. de l'Acad. Royale de Chir.*, 1755, Vol. II, p. 565.

[16]Hubbell. loco cit.

lines) wide at the heel, whence it tapered by gentle convexity of the back and edge to a very sharp point. It was straight on its flat and the back was blunt. It was mounted in a suitable handle by means of a constricted shank half an inch (12 mm.) long. Young's knife seems

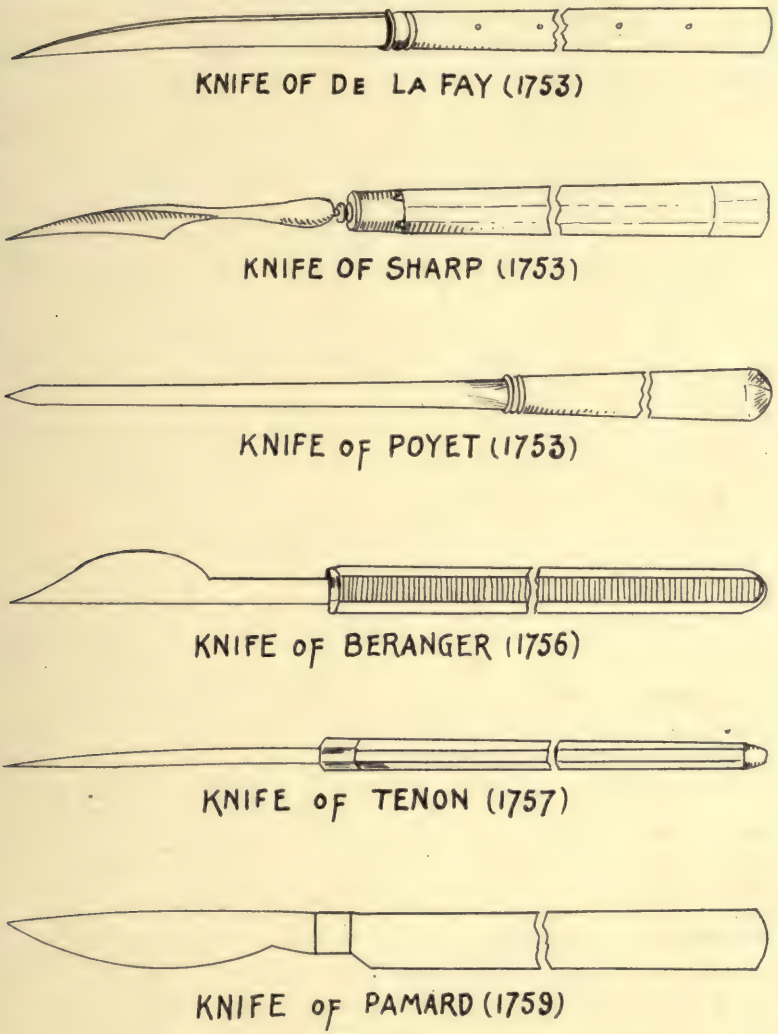


Fig. 565.

First Knives Used in Cataract Extraction. (Hubbell).

to have been overlooked by his contemporaries although it is referred to both by Ens[17] and by Sprengel.[18]

---

[17]Ens. *Historia Extractionis Cataractæ*, 1803, p. 43.
[18]Sprengel. *Histoire de la Médicine*, Vol. VII, 1815, p. 64.

After de la Faye came Béranger,[19] who employed a knife in making the corneal opening of a shape that forecasted the instrument of Beer and Richter. The illustration of Béranger's knife and its use is furnished by de Wecker's[19a] well known work.

Soon there were many more cataract knives. Every new operator seemed to consider it his duty to modify or "improve" some of the instruments employed in the operation, so that in the year 1821 Lachmann reports 69 different knife models!

It was A. von Graefe[20] who first introduced the so-called *linear extraction.* It must, however, be remembered that the incision itself was not original with that celebrated operator because this was precisely the method of opening the anterior chamber adopted by St. Yves (1707), and Petit (1708), when they extracted the dislocated lens from the anterior chamber.

It must also be borne in mind that Pallucci[21] first removed the *remains* of a secondary cataract from behind the pupil through a corneal incision of this variety.

In 1795, also, Santerelli[22] made use of an instrument by means of which he opened the anterior chamber at the upper sclero-corneal junction for the purpose of cataract extraction.

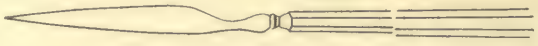


Fig. 566.
Thos. Young's Cataract Knife.

Gibson[23] in the year 1811 removed soft cataracts, as well as thickened capsule, through a linear corneal wound, but has not left us a very definite description of the operation.

F. Jaeger[24] did, in 1813, what is known as the "partial" extraction. Later on Travers[25] first produced a dislocation of the lens into the anterior chamber and then removed it (broken into small masses) through a small *linear* wound in the cornea. He made a larger opening than Gibson.

---

[19]Béranger. Description d'une nouvelle Méthode de faire l'operation da la cataracte par l'extraction du cristallin. A Couplai, près St. Jean d'Angéli en Xaintonage, le 20 Dec., 1757.

[19a]de Wecker. Remin. historiques concern. l'extraction de la cataracte. *Archiv. f. Ophthalm.*, 1893, XIII, p. 223.

[20]von Graefe. Ueber die lineare Extraction des Linsenstars. *Arch. f. Ophthalm.*, 1854, 1, 2, p. 219.

[21]Pallucci. Histoire de l'operation de la cataracte faite a six Soldats invalides. Paris, 1750.

[22]Santerelli. Ricerche per facilitare il cateterismo e l'estrazione della cataratta. Vienna, 1795.

[23]Gibson. *Practical observations on the formation of an Artificial Pupil*, Lond., 1811.

[24]F. Jaeger. *Der Hohlschnitt.* Wien, 1873.

[25]Travers. Further Observations on the Cataract. *Medico-Chir. Transactions*, V. London, 1834.

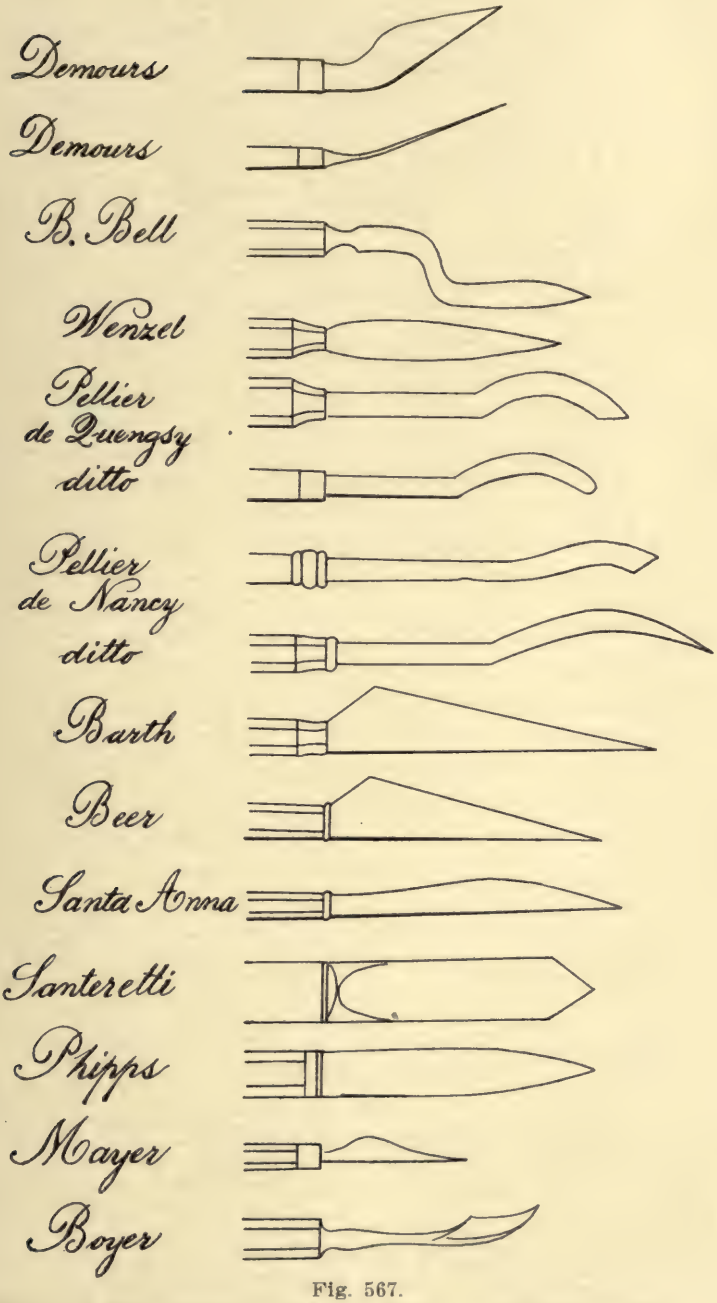


Fig. 567.
Models of Cataract Knives Prior to 1822. (After Lachmann).

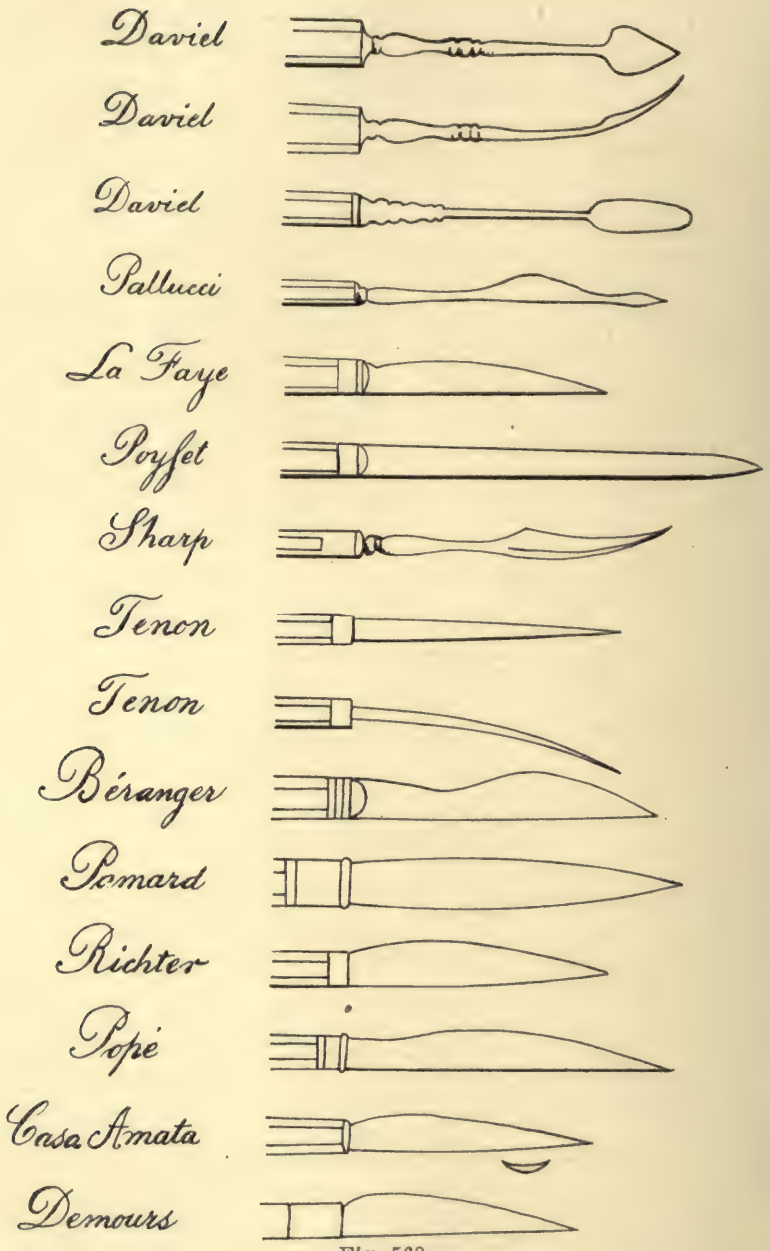


Fig. 568.

Models of Cataract Knives Prior to 1822. (After Lachmann.)

Bowman[27] and Critchett[28] enlarged the incision, made a small corneal flap and extracted the lens with scoops.

Among others Jacobson recognized the fact that incisions within the scleral tissue heal sooner and are less likely to suppurate than when placed entirely in the clear cornea. He revived the lower semi-circular cut but, to avoid prolapse, was obliged to combine with it an iridectomy.

The purpose of von Graefe's earlier incision (1865) was similar to that of Jacobson's—avoidance of infection—and was a combination of a linear wound and a scleral position. As this incision could not be properly made with the keratome-form of knife *(Lanze)* in vogue at the time he invented his well known knife modelled—as he himself says—after the iris knife of Waldau and Fröbelius.

de Wecker[29] suggests that von Graefe appropriated and slightly altered the shape of the de la Faye-Tenon knife for his purpose, but a comparison of the two instruments and the well known probity of the German surgeon preclude our harboring such a suspicion for an instant. It is likely that Graefe did not know of Tenon's[30] work, else he would certainly have mentioned his name in connection with the new instrument. In any event, it was an original application of a modified instrument, already in existence.

The new knife was suited to the work required by it, viz.: the making of a puncture and counter-puncture, and an incision that would be as nearly as possible an arc of the largest possible circle. The original wound began and ended about a mm. from the cornea and a mm. and a half below a tangent drawn through the summit of the circumference of the cornea. After the puncture was made the knife edge was turned forwards and the most of the wound made perpendicular (or nearly so) to the globar surface. This incision, however, proved to be too short so that in 1867[31] it was elongated and combined with an iridectomy and a short conjunctival flap, thus giving rise to the modified (peripheral) linear extraction, to distinguish it from the (1865) (simple) linear extraction without iridectomy.

This method was a favorite operation for many years and al-

---

[27]Bowman. On Extraction of Cataract by a Traction Instrument, with Iridectomy; with Remarks on Capsular Obstructions and Their Treatment. *Royal Lond. Ophth. Hosp. Reports*, Vol. IV, pt. 4, 1865, p. 332.

[28]Critchett. On the Removal of Cataract by the Scoop Method, or the Method by Traction. *Ophth. Hosp. Reports*, Vol. IV, pt. 4, 1865, p. 315.

[29]de Wecker. Remin. historiques concern. l'extraction de la cataracte. *Archiv. d'ophtal.*, Vol. XIII, 1893, p. 217.

[30]Tenon. See Hubbell, *loco. cit.*

[31]von Graefe. The evolution of the final procedure, from the earliest method employed by this operator with the wide keratome, is recorded in the following papers, published in the *Archiv. f. Ophth.*, 1865-1868. Übermodifizierte Linearextraktion; Nachträgliche Bemerkungen über die modifizierte Linearextraktion; Notiz über die Linsentbindung, etc.; Weitere Zusätze über das Verfahren des peripheren Linearschnittes.

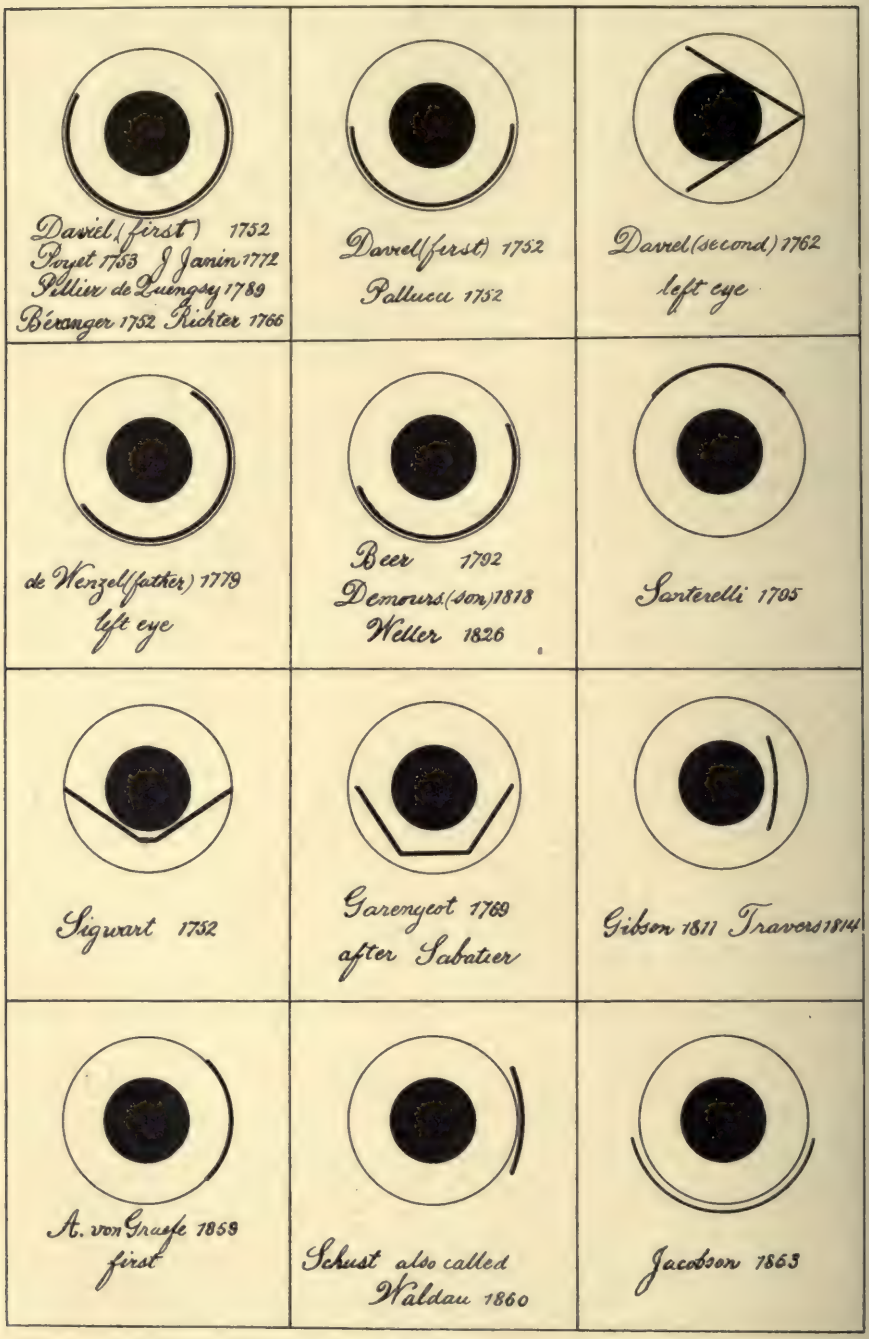


Fig. 569.

Diagrams Showing the Lines of Incision in the Principal Types of Cataract Extraction to Our Own Times. *(Encyclopédie Française d'ophtalmologie.)*

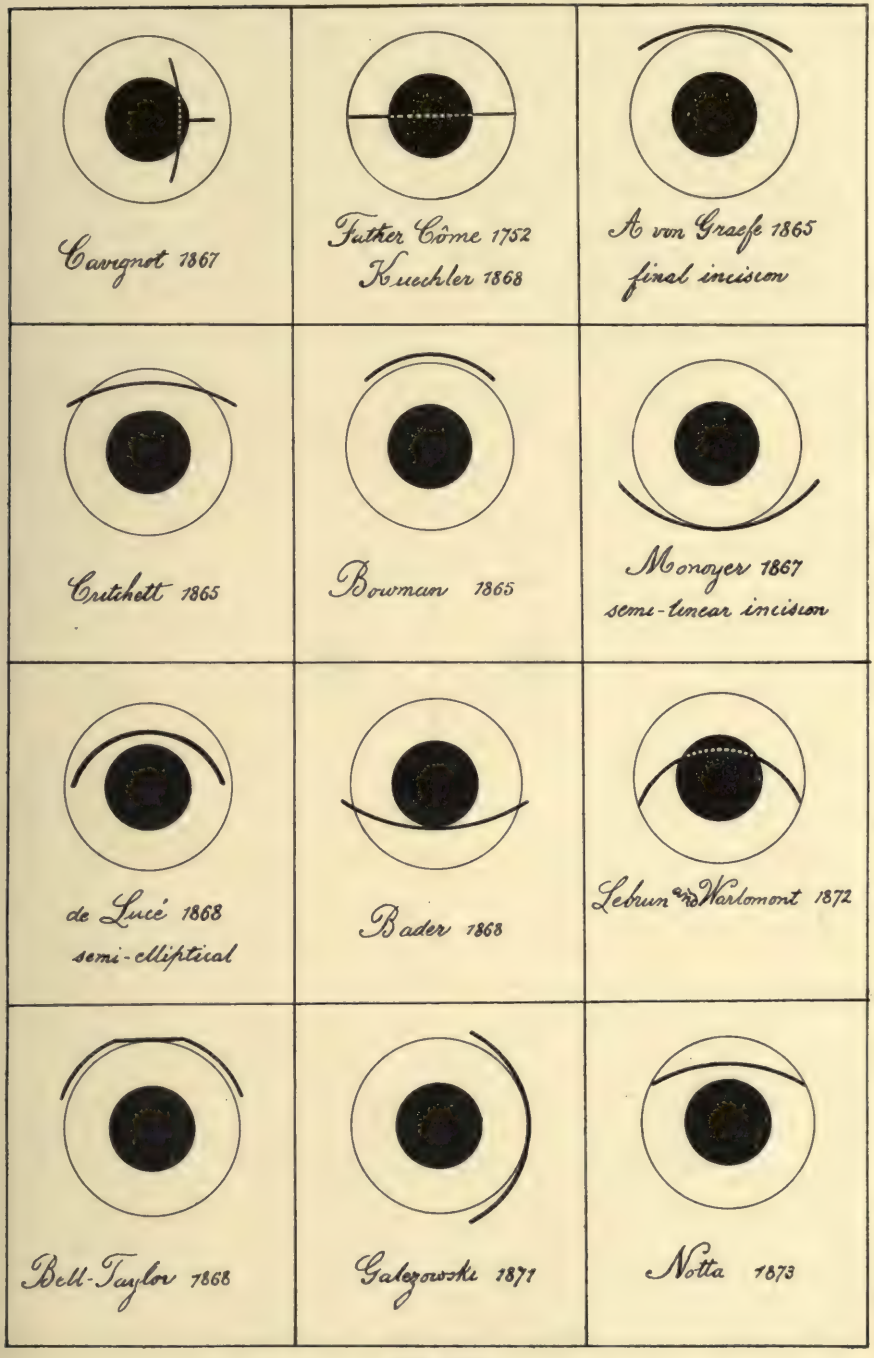


Fig. 570.
Diagrams Showing some of the Lines of Incision in Senile Cataract.

though other procedures were introduced from time to time, it held its ground until comparatively recent times. Nevertheless, it was noticed that while the proportion of suppurating wounds and panophthalmitis decreased there was rather an increase in sympathetic ophthalmia and in cases of "quiet" uveitis. Moreover, the operation required considerable skill; it was difficult to make the incision properly and the delivery of the lens (especially if it were a large one) through the small opening was a difficult task. Hemorrhage into the anterior chamber, loss of vitreous, prolapse of the iris, cystoid cicatrices, etc., were not infrequent.

Among others, Weber[32] sought to remedy these defects by a linear incision made with a broad, lance-shaped knife [on the earlier Santerelli (1795) and Jaeger (1865) models] with rounded angles. But even this section, which was ten mm. long, was not sufficient to permit of the easy extraction of large cataracts.

Henry Howard[33] used an *arrow-headed* knife of the Weber variety which forms the flap without making a counter-puncture, and renders

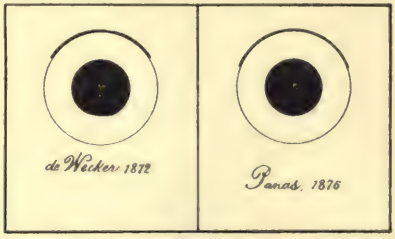


Fig. 571.

Diagrams of the de Wecker (1872) and Panas (1876) Corneal Sections in Senile Cataract Extraction.

the operation much more simple. The following is a description of the instrument and some of the steps of the operation in which it was employed:

"It is trowel-shaped; the handle, similar to the handle of all eye instruments, and has a curve from the handle to the blade, to give room for the fingers of the assistant in holding up the upper eyelid, and for the depth from the superior edge of the orbit to the globe of the eye. The blade is rather convex on the back, and concave on the front, having its cutting part on the front edge. Its greatest width is nearly equal to the transverse diameter of the cornea. Its depth is about half the perpendicular diameter of the cornea. There is a guard to the knife to prevent its slipping into the anterior chamber further than is intended by the operator. Now, if with this knife the upper part of the cornea is pierced at about 1/20 of an inch from the sclerotica, and exactly in the perpendicular diameter, and the handle then brought backwards and upwards, it will bring the back of the blade parallel with the anterior part of the iris; the operator must then push the

[32]Weber. Die normale Linsentbindung der modifizierten Linsenextractiongewidmet. *Arch. f. Ophthal.*, Vol. XIII, 1867, p. 187.

[33]Howard. *The Anatomy, Physiology and Pathology of the Eye.* Montreal, 1850, p. 436.

knife downwards till its point comes near the bottom of the anterior chamber of the eye, at which time its guard will be at the transverse diameter, or nearly so, and the upper half of the cornea will be formed into a flap. That this section may be perfect, the surgeon should be cautious to watch the point of the knife so as to keep it exactly in the perpendicular diameter while carrying it through the anterior chamber; he must also be sure that its back is parallel with the front of the iris. The operator may then cautiously withdraw the knife, but previous to doing so, he should let some of the aqueous humor escape. After the knife is withdrawn the operator and assistant should let go the lids, and the patient must remain as quiet as possible."

Howard believed that many advantages arose from making the flap with this knife; in the first place there is no danger of the iris

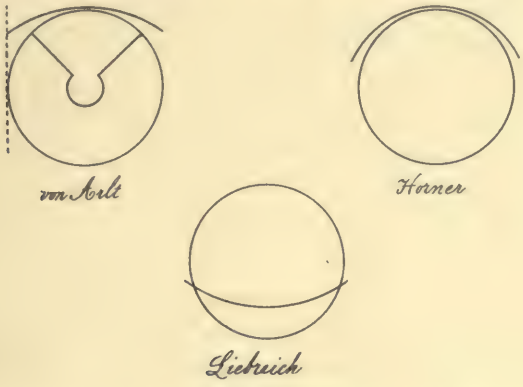


Fig. 572.
Diagrams Showing Lines of Incision (Continued).

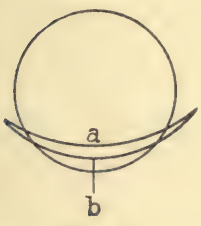


Fig. 573.
Diagram Showing Incision of Steffans.

Fig. 574.
Modern section; Showing Small Conjunctival Flap.

falling before the edge of the knife, and the operation may be performed with the right hand on both eyes.

Arlt,[34] his pupil Becker,[35] and Frau Kerschbaumer[36] long employed a slightly modified form of the later Graefe incision, but increased its length to 12 mm.

---

[34]Arlt. See the chapter, Operationslehre, in the first edition of the Graefe-Saemisch *Handbuch der ges. Augenheilk.*

[35]Becker. Die Universitats-Augenklinik in Heidelberg, 1888.

[36]Kerschbaumer. See my translation of her article, Bericht über 200 Staretractionen, in the English edition of the *Archiv. f. Augenheilk.*, Vol. XXII, 1890, p. 127.

The foregoing considerations led, in the course of 15 years, to the adoption of several other forms of corneal and scleral incisions. Liebreich,[37] for example, introduced a downward incision without iridectomy, performed with a narrow Graefe knife that inclined downwards and forwards at an angle of 45 degrees. The puncture and counter-puncture were in the sclera, both 1 mm. from the limbus and 2 mm. from the horizontal meridian. The middle of the wound lay about 2 mm. from the sclero-corneal junction.

Even earlier than Liebreich came Küchler[38] who made a direct horizontal cut across the cornea. Although the disadvantages of this incision are at once apparent, yet it had considerable vogue for a time—especially in France—much as the Liebreich incision was for a while fashionable in England. Giraud-Teulon[39] and Vibert,[40] for example, practised a slight modification of it. As proof that there is "nothing new under the sun"—not even a bad operation—Tavignot[41] claims to have established priority of publication but, as Czermak[42] remarks, neither of these contestants for the honor of discovery was aware that the method had been practised by Frère Côme previous to 1751 and that Daviel, who knew all about it, called it a "comic operation."

Fig. 575.
Weber's Cataract Knife.

Lebrun,[43] about this time, introduced his upper section (made entirely in the cornea) with a short, shallow flap. Both puncture and counter-puncture were made 2 mm. below the horizontal meridian. The knife used was quite narrow and the plane of the incision lay at an angle of about 30 degrees to the iris surface. The summit of the incisional arc corresponded to the upper margin of the undilated pupil.

The flap operation again came into vogue but it took the form of an *upper section* without a conjunctival flap.

De Wecker (see figure) was among the first to utilize such an incision, which followed exactly one-third of the corneal circumference. The base of the flap was 11.32 mm. long and 4 mm. high. This did not produce a sufficiently large opening which, by the way, was not

[37] Liebreich. Eine neue Methode der Kataractextraction, Berlin, 1872.
[38] Küchler. Die Querextraction des grauen Stars. Erlangen, 1868.
[39] Giraud-Teulon. See reference in the *Klin. Monatsbl. f. Augenheilk*, Vol. II, 1873, p. 344.
[40] Vibert. Nouveau procèdé d'operation de la cataracte. *Gazette hebdom*, 1878, p. 511.
[41] Tavignot. *Gazette des Hôpitaux* Vol. XXX, 1863, p. 118.
[42] Czermak. *Augenärztliche Operationen*, Vol. II. 2nd Ed., p. 323.
[43] Lebrun. *De la cataracte*, Paris, 1872.

generally adopted until the discovery of antiseptic and aseptic measures made safer an increase in the size of the wound.

Types of Extraction Methods.

Although the modern modes of cataract removal are quite numerous, they may be divided into four principal categories. The list comprises the following: (1) The simple (without iridectomy) form of extraction, (2) the combined (with iridectomy) form of extraction, (3) extraction of cataract in the unruptured capsule, and (4) variations in one or other of the foregoing classes.

Speaking of the *choice of operative measures*, Landolt[44] quotes a letter to him from Bowman in which the latter says:

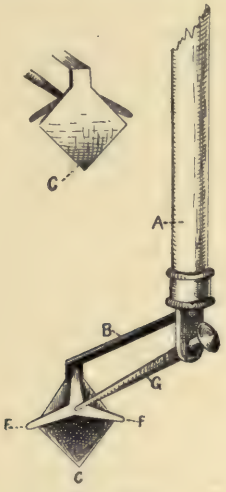


Fig. 576.

Henry Howard's Arrow-Shaped Knife for Cataract Extraction.

[The cut is not in true perspective.]

Fig. 1 A. The handle about four inches long.
B. The arm carrying the blade—¾ of an inch.
C. The triangular blade.
D. D. The extreme width of the blade.
E. E. The extreme depth of the cutting part.
F. F. The guard which prevents penetration to too great a depth.
G. The screw which secures the guard, and permits its removal to allow the blade to be sharpened.
Fig. 2 C. The back of the blade (full size).

"You are perfectly right; I never laid down a method of extraction of cataract universally applicable. I always operated as seemed best at the time for the individual treated. I cannot doubt that the problem of what is to be accounted the best method in any class of cases will have to be worked out by our successors, and theirs, too; but ever remaining open to modifications to suit the thousand personal circumstances of our patients."

[44] Landolt. Der gegenwärtige Stand der Staroperation. *Beiträge zur Augenheilk.*, VI, 1892, p. 25.

Must the Operable Cataract Be Mature?

It was formerly strongly held (and there can be little doubt but that uncomplicated, completely and uniformly sclerosed cataracts are most easily and satisfactorily extracted) that one should wait until the cataract is "ripe" before operating, it matters not how much the patient may suffer from blindness and interference with his daily occupations. For many reasons, which cannot be discussed here, ophthalmic surgeons are now-a-days inclined to operate, for example, on *one* eye of patients with bilateral cataract—preferably the more advanced—as soon as failing vision interferes with their usual avocation. Brudenell Carter,[45] for example, voices this belief, and Bulson[46] discusses the question in all its relations. Mark Stevenson[47] pertinently remarks:

"A little red reflex or the presence of transparent cortex does not deter me from operating, provided the vision of neither eye is sufficient for the patient's needs, that the cataract is slowly progressive, that the field of projection is good, and that there is no suspicion of serious intraocular disease, e. g., beginning retinal detachment or the various forms of choroido-retinitis. Granting that mild iritis is more common and that an operation for secondary cataract is more often required after operating on immature cataracts, is it not even then better to operate than to keep the patient waiting months and sometimes years? The final results should be as good as after the extraction of mature cataract, and vision is restored much sooner, thus aiding the general health."

Beard[48] believes that even if the fellow eye have useful vision it is

"not only justifiable but advisable to *remove a cataract from an eye whose fellow is normal*, provided the stage of opacity is fit and the conditions in general are favorable. It is the duty of every individual to obtain what sight is possible in both eyes in order to have a wholesome reserve in the event of an emergency. True, the immediate result is not so gratifying, either to the patient or to the operator, be the operation ever so successful, as the former cannot appreciate the added vision, especially when, as it sometimes happens, an annoying diplopia ensues. *Later this will disappear,*[49] whereas, if left alone the cataract would reach a stage not so favorable for extraction. It is also an error to assume that binocular single vision is impossible in such cases."

Shall the Operation Be Undertaken on Both Eyes at One Sitting?

There is almost a unanimous opinion against the *removal of bilateral cataract at the same sitting* mainly because disaster might follow

---

[45]Carter. *Lectures on Cataract.*

[46]Bulson. The Extraction of Uncomplicated Immature Senile Cataract. *Jour. Am. Med. Assn.*, Sept. 23, 1905.

[47]Stevenson. Some Important Considerations in the Extraction of Cataract. *Presess. Reprint, Oph. Sec., Am. Med. Assn.*, June, 1906.

[48]Beard. *Ophthalmic Surgery*, p. 481.

[49][Not always. I have had one unfortunate case that closely resembled that reported by Snellen: Operationslehre, *Graefe-Saemisch Handbuch der ges. Augenheilk.*, 2nd Ed., p. 52. After the perfectly successful extraction of a unilateral cataract the patient, a man aged 53, did not become accustomed to the unequal images, and as long as he remained under my observation (several years) was obliged to wear a shade over the eye operated on. This unhappy condition persisted in spite of all sorts of devices—optical and other—intended to relieve the diplopia and mental confusion attendant upon the attempt to go about with both eyes open. W.]

some unforeseen accident likely to destroy both eyes. Howard Hansell is, however, in favor of this form of double extraction.

Condition of the Patient's Health in Cataract Extraction.

As the removal of hard cataract is mostly demanded by elderly subjects one must expect to find in them those changes commonly known as *senile*—especially angio-sclerotic alterations. These, therefore, are no bar to the operation, although it is always proper to have a *thorough systematic examination made of the candidate for cataract extraction,* if for no other reason than that the information thus obtained may modify the pre- and post-operative medication or dietary and other regulations to which cataract patients are generally subjected. It may also enable the surgeon to insure the patient's comfort or even anticipate possible accidents during and after the operation. For example, patients with the various forms of asthma cannot keep the prone position for any length of time, and there are many old people who when condemned to lie quietly in bed for more than a few hours develop all sorts of symptoms, varying from acute abdominal pains—frequent experience—to acute mental anguish. These and other idiosyncrasies should, therefore, be the subject of inquiry and consideration as ante-operative precautions.

Extreme old age is not in itself an unsurmountable barrier; indeed, the literature of the subject and the experience of most surgeons prove that many a patient over ninety years of age has been operated on with success and has enjoyed several years of eyesight.

Whatever their origin, *cough, constipation, diarrhea, and marked insomnia* should, so far as possible, be relieved as they greatly add to the dangers of the extraction. Imminent death is, of course, a bar to the operation. It is partly on this score that Herbert[50] declines to operate on cases exhibiting *extreme anemia, menstruation, albuminuria with anemia and general edema,* or recent syphilis. Apart, however, from such serious considerations as these, the removal of the cataractous lens is not prohibited if, by means of hygienic and other therapeutic aids, the surgeon brings his patient into as satisfactory a state of health as the systemic conditions permit.

Shall We Operate at a Hospital or in a Private House?

The surgeon will often be obliged to discuss this question. When he has access to a well equipped hospital, public or private, he should insist upon the operation taking place there, meantime pointing out to the patient and the patient's friends that a serious operation of the projected kind should be carried out under the most favorable surroundings, and that an operation even in the best regulated house adds

[50]Herbert. *Cataract Extraction,* 1908, p. 17.

considerably to the post-operative dangers. As is well known, the environment of the patient in the average hospital conduces to the success of a cataract extraction in a much larger measure than when the operation is done even in the homes of the well-to-do.

Should the surgeon decide to do the operation in a private dwelling the preparation of the operating room should follow the lines laid down in Byers' Chapter.

The Pre-operative State of the Ocular Apparatus.

No operation for the removal of cataract should be undertaken as long as *either eye* is a subject of an active disease—especially one of an infective character. All forms of conjunctivitis should be treated and, if possible, cured.

Diseases of the neighboring cavities that contribute to the congestion or infection of the ocular apparatus should also receive attention. Above all, acute catarrhal *diseases of the lachrymal canals*—particularly dacryocysto-blennorrhea—should have strict attention. Trachoma, unless it is in the well advanced cicatricial stage or when its complications are curable, is a bar to operation. A test bandage may be placed over the eye for one night and the discharge subjected to a bacteriological examination. If pyogenic microbes are discovered the operation should be delayed until the infection is properly treated. As an additional precaution, or if there be urgent reasons for an early operation, a temporary ligature may be placed about the canaliculi, as originally recommended by Knapp,[51] and further employed by Buller, Bulson and myself.

Gifford[52] advises slitting the upper canaliculus and filling the tear passages with some indifferent substance in cases that present themselves several days before operation. The puncta may also be closed by the actual cautery. If the operation is not an urgent one, extirpation of the sac and other effective treatment of the infection itself should be practised. In the same way *pterygium* should, generally speaking, be removed before an extraction.

Finally, the skin of the lids should be free of disease.

Meibomian glands and ducts are likely to harbor pathogenic microbes whose removal is to be desired. Recently I have had my assistant thoroughly massage the lids over the eyeball before applying the preliminary bandage as well as on making the final preparation before operating. This process is facilitated by the presence of the White's ointment introduced for the purpose of active sterilization.

---

[51] Knapp. *System of Diseases of the Eye*, by Norris and Oliver, Vol. III, p. 896.

[52] Gifford. The Essentials and Non-Essentials of Ophthalmic Asepsis. *Trans. of the Sec. on Ophthalm., Am. Med. Assn.*, 1903, p. 146.

Arcus senilis is no particular obstacle to the operation, although it is well to avoid this corneal alteration while making the incision.

There are very few *pathological processes involving the iris* that act as a barrier to the successful performance of the operation. Nevertheless, it is desirable that the patient should have a healthy iris and that the pupillary reactions should be altogether, if not quite, normal. Herbert[53] believes that an eye exhibiting normal pupil reactions is not likely to be the subject of complications.

THE EDITOR'S ROUTINE METHOD OF UNCOMPLICATED, NORMAL CATARACT EXTRACTION.

Preoperative Disinfection of the Operative Field.

Having fully treated all forms of local infection the routine preparation of the patient largely consists in rendering as sterile as possible the conjunctival sac. We know, from the labors of many bacteriologists, that while it is impossible to render the sac absolutely sterile, yet the deleterious action of morbific germs may be largely neutralized by simple cleansing. Stevenson *(loco cit.)* begins the sterilization a week before the operation and I regard this as good practice, especially when there is *any* discharge from the eye. He uses an eye-cup (which can be easily sterilized) with a saturated solution of boric acid, and furnishes patients with the following instructions:

"The eye bath, about one-third full of the solution, should be gently pressed against the closed eyelids while the head is slightly inclined forward. The head is then slowly thrown backward, the lids are opened and closed repeatedly and the eye bath moved slightly from side to side, during time required to count 40, so that the solution may completely wash out the eye sac. The head is then again inclined forward when the eye bath is removed (the eyelids remaining closed for a few minutes), and its contents, which should be used for one eye only, thrown away. The bath is also used on the morning of the operation and about an hour before operating, after which a sterile eye-pad is fastened in place by adhesive strips."

In addition to this simple form of cleansing I am in the habit of having the eye-brow shaved, and the cilia cut off close to the lids. I am aware that there are many objections to the removal of the eyelashes and eye-brow, but it is well known that hairs furnish a fruitful *nidus* for germs. Moreover, during the operation they frequently get in the way and may act as an embarrassment to the operator. If, however, the patient raises much objection to their removal I generally compromise by cutting off a few cilia from the outer and inner canthi and clip the hairs of the eye-brow when these are long. Then I insist upon scrubbing the brow with green soap or benzine (or both) as an additional precaution. I do not like the application of benzine to the

[53] Herbert. *Cataract Extraction.*

eye-lashes as it generally gets into the eye and produces considerable congestion of the globar vessels.

The conjunctival sac is then filled with White's ointment (the night before the day of operation) and a triangular bandage, elsewhere described, applied. The eye-pad of this dressing is removed when the patient is lying on the table and again the conjunctival sac is gently irrigated with a Todd or other apparatus, the stream of warm boric acid or normal salt solution being directed towards both sulci, so as to wash out their contents. The whole region of the eye is then thoroughly cleansed of the remains of the White's ointment. In addition to these precautions the neighboring facial skin is well rubbed with warm boric acid solution.

The *nose* should receive quite as much attention as the lachrymal apparatus and not only should all nasal affections have rigorous preoperative treatment, but I am in favor of spraying the nasal cavities either with the solution suggested by Lippincott[54]—1-2,000 of potassium permanganate—or with some similar liquid.

Other Preoperative Considerations.

Although the preparation of the surgeon and his assistants, the patient, the instruments, the dressings, etc., preliminary to operations in general have been completely treated in Dr. Byers' chapter (q. v.) and elsewhere, yet there are several matters introductory to a description of cataract extraction of such special importance that they, even at the risk of repetition, should be considered here.

Wherever the operation be performed the patient should be admitted at least 24 hours in advance so as to give sufficient time for the necessary preliminaries.

If the patient be accustomed to taking a full bath he should have one, otherwise a sponge bath is in order.

It is also desirable that a *cathartic* (preferably combined with calomel) should be given the first evening, followed by some saline mixture the following morning. In this connection it is generally advisable to consult the patient as to the form of laxative that he is in the habit of using. Elderly people generally have a choice of these remedies and it is wise to consider it.

The *food* should be as light as possible and here, too, the patient should be consulted in framing a diet-list. As before stated, the regime ought to be consistent with the findings of the systemic examination. As a rule, however, a light, easily digestible diet, plenty of water, a well-ventilated room and such other comforts as the patient has been accustomed to will form the best basis for his hygienic treatment.

---

[54]Lippincott. *Jour. Am. Med. Assn.*, 1900, p. 930.

A Preliminary Training.

The patient should understand that his assistance is highly desirable before, during and after the operation, and one should not neglect making to him this statement which has a tendency to induce his active co-operation, gain his confidence and to place both surgeon and patient upon a proper footing.

I am in the habit of having a quiet talk with each patient upon two or three occasions preceding the operation, of exercising him in rotating his eyes in various directions, everting the lids, etc., and endeavoring to get him accustomed to my own manipulation of the parts about to be operated on. I believe it is wise to do this (as elsewhere stated) not only a few minutes before the operation but on other occasions. These manipulations tend to familiarize the patient with the idea of operation and should rarely be omitted.

Further Preparation of the Operator and Patient.

The operator should wear a cap, to prevent dandruff and other infective material from falling upon the operative field from his hair. Both surgeon and patient should wear a mouth and nose mask, to prevent globules of saliva and other infective exhalations from reaching the eye, either from the patient or from the operator. It is a rational proceeding, when one considers that the breath and saliva are both likely to contain cocci, that at least the mouths of patient and operator should be shut off from the operative field.

In addition to these precautions I am in the habit of covering the remainder of the face with two single layers of sterile gauze wet with warm boric acid solution. An opening is made in this, corresponding to the margins of the orbit, large enough to admit the speculum and to allow of the usual operative manipulations. After pressing this covering firmly upon the skin the wet gauze will adhere closely and will not interfere with the surgeon's work.

Thus prepared there is little or no danger of infecting the surgeon's hands or his instruments by contact with any portion of the patient's face.

Mark Stevenson,[55] for the purpose of directing the patient's breath away from the eye, advises that a strip of adhesive three or four inches wide and six or seven inches long be covered with gauze on its adhesive side, with the exception of about one-half an inch of its width along one margin, throughout its entire length. By this upper uncovered margin it is fastened across the bridge of the nose and both cheeks, an inch or more below the eyes, so that it hangs down over the nose and

[55]**Stevenson. Some Important Considerations in the Extraction of Cataract.** ***Oph. Sec. A. M. A., Presession Reprint,*** **June 5, 1906.**

mouth and directs the patient's breath and saliva away from his eye. It should then be covered with sterile gauze.

He also advises that, instead of the usual surgeon's mouth and nose mask, a strip of gauze a yard long may be drawn over this frame so that the ends meet below. The lower ends of these strips for a distance of ten or twelve inches are then split by scissors and the two halves, one on each side, tied or fastened by a safety pin behind the neck so that the gauze hangs over the mouth and passes under the chin around the neck. As many layers of the gauze may be used as are thought to be necessary. With this appliance the surgeon's breath will not pass upward into his own eyes or blur his operating glasses, but pass out to the side, and all saliva or excretions from the nose will be arrested in the gauze; and he can still talk and breathe freely.

Any preparation that can possibly be made *before the patient's arrival* in the operating room should be carried out, mainly that the conscious subject of it should not have too long to wait before the welcome announcement that "it is all over." I have sometimes been obliged, owing to incomplete arrangements or incompetent operating-room assistance, myself, to wait and have seen the same occurrence with other surgeons, until the unhappy patient has been brought into such a state of apprehension and excitement that he was unable to give any assistance towards a proper completion of the operation.

Bringing the Patient to the Operating Room.

This is sometimes of importance, especially in the case of nervous persons whose confidence one wishes to obtain or retain and whose courage one desires to strengthen. When a patient is ceremoniously wheeled or carried into the room he generally imagines that something dreadful is going to happen, whereas if he can be allowed to walk in and the matter treated as of little moment, he is not so likely to be excited by subsequent proceedings. On reaching the operating table he should be directed to mount it by the aid of a strong step or box, then to sit down upon its middle, then to lie down and rest his head upon the thin, firm pillow provided for the purpose.

Some operators use a special operating table, or chair, but as a rule any form of operating table of modern construction will be sufficient. While the assistants and nurses are preparing the instruments, dressings and other applications, it would be well for the surgeon, who has in the meantime been dressed and prepared for the operation, to superintend the placing of the patient upon the table and in as quiet and gentle a fashion as possible direct him how to give his assistance during the operation. It is just here that the operator may become so acquainted with the subject upon which he is to operate as to avoid many of the

accidents that are liable to happen to a suspicious, frightened, or otherwise demoralized patient. It is also at this time that the patient may be instructed how to turn his eyes in various directions and what to do under certain contingencies. If he cannot easily fix his eyes he may be directed to look towards his feet, or straight forward, or at the face of the surgeon who is speaking to him. A certain amount of handling of the patient's face and eyes is also desirable, that he may become accustomed to the subsequent operative manipulation. I generally wash out the sac, cleanse the eyelashes, massage the lids, or perform some other part of the preliminary sterilizing.

It always does good to reassure the patient that he will not be seriously hurt and I generally tell him that if he will be quiet, and not under any circumstances squeeze up his lids, that there will be little or no pain. There are certain stock phrases which may, with considerable benefit be employed on such occasions. For example, I usually say to the patient, "It will be time for you to get nervous when you notice that I am nervous," and "Most people never know when the operation has begun or when it is over." It is also a good plan not to allow anybody in the room to speak above a whisper. I generally remark in the presence of the patient that the operator ought to do all the talking and the other people in the room, including the patient, should be mere listeners. When that is accomplished the surgeon should never raise his voice, never speak quickly, but should talk and act quietly and deliberately until the patient has left the operating room. If the operator has any fault to find with the preparations, with any of his assistants, or with himself, he had better do it when the patient is not present. It need not be added that loud talking, gesticulating and storming about the room have no effect other than to fluster and demoralize the patient and to jeopardize the success of the operation.

Just before the operation and after the cleansing of the whole field—an act that should be carried out with great care and without doing anything that will irritate or be unpleasant to the patient—I am in the habit of putting a drop of cocain solution *into the fellow eye.* This insures the minimum danger of the patient's "squeezing up" both eyes should a drop of solution fall into the fellow organ or should it be touched by the assistant or by any portion of the dressing. During the anesthesia, which should now follow, a thin layer of absorbent cotton, wet with warm boric acid solution, is placed upon the closed lids and the patient told to keep both eyes shut until he is asked to open them.

Local Anesthesia.

My favorite anesthetic is a sterile mixture of holocain (1 per cent.) with cocain (4 per cent.). One drop of this combined solution is instilled into the eye every two minutes for ten minutes, the operation

being begun in from ten to fifteen minutes after instilling the first drop. As I generally make a conjunctival flap, I believe in instilling with, or immediately after, the last drop of cocain, one drop of a 1-1,000 solution of adrenalin or suprarenalin. Used in this way it *checks the bleeding* which, to my mind, is *the most serious drawback to this form of extraction.*

The idea that filling the conjunctival sac with the anesthetic solution, or its application every few seconds for a long time, will have any effect except a harmful one should be permanently discarded. The conjunctiva and cornea will not absorb more than a certain amount of liquid, it matters not how often or how much of it is applied. This very unnecessary dosage results in a waste of expensive material, a reduction of the tonicity of the globe, post-operative hemorrhage, possible exfoliation of the epithelium of the cornea, as well as in danger of poisoning the patient. In the interval between these instillations, and when nothing is being done to the eye, the lids should be kept closed and protected by a cotton pad wet with warm borated solution.

At any stage of the operation it is desirable, when the patient's eyes are closed or covered (and some manipulation is about to be done) to place a finger upon the forehead so as to warn him that "something is coming"; then, to tell him what that "something" is, whether it be to put a drop into his eyes, a speculum between the lids, or what not. Of course, it is not necessary to definitely specify the act that is to follow, but merely to give him an idea of it. This strengthens the patient's confidence in the operator, prevents him from wincing or squeezing up his lids, and will generally be found a useful plan to follow.

The Illumination.

As this important subject is fully referred to in T. A. Woodruff's chapter, it will only be necessary to say here that my own preference is for natural light when a good northern illumination can be had. Otherwise I believe that a hand electric lamp of about 10-candle power—which is about equal to the so-called 16-candle power burner—so shaded and held by an assistant that the light falls upon the field of operation obliquely from the side of the table opposite the surgeon, is the best form of artificial light one can have. I am aware that some operators wear a head mirror, that others like a light focussed upon the patient's eye by means of a strong convex lens, and that still others like direct sunlight; but the diffuse, soft light that falls from the upper part of a north window—cross lights being shut out—is less irritating to the patient and better adapted to the operator's vision than any other.

The Use of a Lighted Candle as a Fixation Object for the Patient During Operations for Cataract.

Priestley Smith (p. c.) has not published this device but demonstrated it to many friends—amongst others to the late Professor Snellen[56] who adopted it permanently. He operated in a black-walled chamber by light from a window, but the writer usually prefers to darken the ordinary operating room and to use a lamp for his illumination. In either case the lighted candle enables the patient to direct his eye just as the operator may desire.

Position of the Operator and His Assistants.

Unless he be ambidextrous the surgeon should stand at the head of the table when operating on the right eye, and to the left side for the left eye.

Webster Fox and others use an operating table out of whose left side a segment is cut so that the body of the operator may be better accommodated while operating on the left eye and, for some surgeons, this is a considerable advantage.

The two assistants should be dressed and prepared exactly like the operator.

The first assistance, in charge of the instruments, stands on the left, and the second assistant, if there be one, on the operator's right.

Putting in the Speculum.

The assistant in charge of the instruments now hands the speculum to the surgeon who, addressing the patient, says, "This is something I am going to put into your eye to help you keep your lids apart, without hurting you." Holding the body of the speculum between the thumb and index finger he asks the patient to look down and then deftly and gently places the upper limb of the blepharostat in place. Then the patient is asked to look straight ahead, the lower lid is pulled down and the lower limb put in place, when the spring of the speculum is allowed slowly to separate the lids. If there is any disposition on the part of the patient to wink or blink with either eye, or if the lids do not separate sufficiently under the pressure of the spring alone, the patient should be asked to open the eyes wider and the surgeon should gently separate the limbs of the blepharostat.

The cornea and sac are now gently flooded with warm boric acid solution, which is soaked from the corner of the eye with a damp cotton sponge. Before this irrigation the patient should be warned that "this is only a little warm water to wash out the eye." The surgeon is now quickly but quietly handed the fixation forceps and the cataract

[56] Snellen. Notes on Vision and Retinal Perception. *Trans. Oph. Soc. U. K.*, Vol. XVI, 1898, p. 20.

knife. Some surgeons direct the second assistant to place his left hand on the patient's forehead and to press firmly on the brow and upper margin of the orbit, keeping the hand and forearm well down and out of the way of the operator. This proceeding is useful in preventing spasm of the orbicularis and "squeezing" of the lids.

Fixing and Steadying the Eyeball.

By common consent the area of fixation is close to center of the lower-inner fourth of the limbus. The forceps are placed against the eyeball in this region *closed,* and then allowed to open 2 or 3 mm. The loose, underlying structures are thus put somewhat on the stretch so that when the jaws of the forceps are again closed they do not pick up too much of the conjunctiva and do not lacerate that membrane. Some pressure should be exerted at the time of closing the forceps so that a good, deep bite is taken of the tissues. I always use and much prefer small or medium-sized *forceps without catch or lock.* The teeth should not be too pointed nor should they be too dull. In the first instance they will tear or cut the conjunctiva, and in the second their

Fig. 577.
Senile Cataract Extraction.
The Puncture Properly made. The Point of the Knife has Penetrated the Anterior Chamber Exactly at the Limbus.

grasping power is not sufficient. Some operators twist the forceps half way around so as to gain a better hold upon the eyeball but this manoeuver sometimes results in laceration of the conjunctiva and, in any event, is generally unnecessary if a firm hold is taken upon the subconjunctiveal tissue by a proper adaptation of the forceps' teeth.

The hand holding the fixation forceps now rests upon the patient's nose and opposite cheek and this position is steadily maintained, care being taken *neither to press upon the eyeball nor to drag the conjunctival tissues away from it.*

The Puncture and Counter-Puncture.

The surgeon now examines for an instant his knife edge—to insure its upward direction. He rests his little finger on the cheek of the patient and tells him to look down at his feet. Some surgeons direct the patient to hold both eyes and mouth open, and this is generally a good plan as it assists in hypnotising the susceptible patient and directing his attention away from the operative work that is being done upon

his eye, and so renders less likely orbicular spasm or deliberate "squeezing" of the lids.

The handle of the knife, held as one would a pen, is elevated at an angle of 45 degrees to a tangent of the corneal curve and a puncture into the anterior chamber made at the apparent sclero-corneal junction just above the horizontal diameter. As soon as the point of the knife has entered the anterior chamber the handle is depressed so that the blade may be pushed across the anterior chamber nearly parallel with the plane of the iris and *towards the center of the pupil.* When the pupil is reached the knife handle is again moved towards the pa-

Fig. 578.
Senile Cataract Extraction.
The Puncture Badly Made. The Knife Point has not Reached the Anterior Chamber but has "Split" the Cornea and is Buried in its Substance.

tient's feet and a *counter-puncture* made as nearly as possible at a point exactly opposite the puncture.

The Sclero-Corneal Section.

Then by firm, steady and regular to-and-fro movements—pushing and pulling—the blade cuts its way towards the upper limbus. First, the point is pushed forward and inward towards the nose, then it is pulled outward and upward towards the temple, and these motions al-

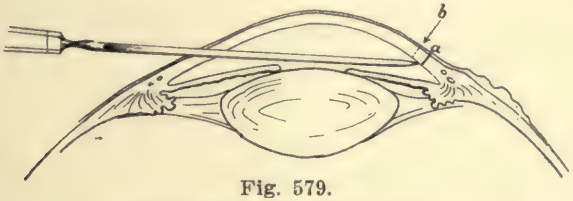


Fig. 579.
Senile Cataract Extraction.
The Counter-puncture should be made at *a*, although in Obedience to the Laws of Refraction, the Point of the Knife appears at *b*.

ternated until, *always following the apparent sclero-corneal junction* the middle of the blade reaches the uppermost sclero-corneal margin.

Making the Conjunctival Flap.

It is then given a one-eighth turn backwards and made to cut its way out beneath the conjunctiva so as to make a small flap of the latter tissue, from 3 to 5 mm. wide and long. During the corneal incision care should be taken that the point of the knife should not stab the lids

or facial skin. Moreover, the corneal section should not be completed with a jerk as this procedure sometimes causes the patient to make involuntary movements or to "squeeze" the lids together.

Advantages and Disadvantages of the Conjunctival Flap.

Whatever form the corneal or sclero-corneal incision may take it is undoubtedly desirable to combine with it a flap from the conjunctiva. Although there are some disadvantages attending this manœuver the advantages are undoubted. These considerations are fully discussed by Herbert[57] from his large experience.

Advantages: 1. The chief function of the conjunctival flap is to serve as a protection against infection. As a covering for the wound it bars the entry of micro-organisms from the conjunctival sac after the operation. The more complete the covering, therefore, presumably the more effective should it be, especially in eyes where the vitreous tends to press the corneal flap forward.

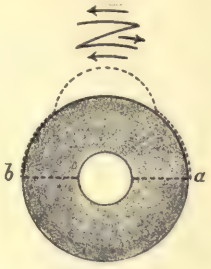


Fig. 580.
Senile Cataract Extraction.
The Arrows Indicating the Knife Movements after the Puncture, *a*, and Counterpuncture, *b*, have been made in the Left Eye. The Black Lines Show the Corneal and Conjunctival Section.

2. The rapid adhesion of a conjunctival flap to the underlying tissues must undoubtedly tend to prevent iridic prolapse. But this statement needs some qualification. Since a cataract incision largely covered by a conjunctival flap must be at least partly sclero-corneal, this peripheral situation of the section, as compared with one in front of the limbus, is calculated to more than counterbalance any benefit derivable from the conjunctival covering. For another reason, any value attributable to the conjunctival appendage as a preventive of prolapse is restricted mainly to the smaller conjunctival flaps.

3. The use of the flap makes the complication of delayed union of the wound, as shown by non-retention of aqueous, a rare one and almost a negligible one. Should the complication occur, it will not persist for long, and will not require treatment, and there is no fear of

[57]Herbert. *Loco cit.*

down-growth of surface epithelium into the anterior chamber, with its subsequent liability to induce probably incurable glaucoma.

4. Herbert attributed the almost complete exemption (in Bombay) from secondary glaucoma to the general use of an extensive conjunctival flap. A permanently filtering cicatrix—rendering rise of tension practically impossible—appears to be the constant and inevitable result of any recognizable separation of the sclero-corneal incision under the conjunctival covering.

5. A minor advantage of the conjunctival appendage is in the use that may be made of it to draw open the wound during operation, for the iridectomy and in the expulsion of the lens.

Drawbacks. 1. During the operation the flap may be a little in the way when the iris is being cut; but the chief trouble from it then is (2) the *hemorrhage into the anterior chamber,* which is to be expected more or less with any extensive flap unless adrenalin[58] has been instilled. This blood is not only a nuisance at the time, interfering with the capsulotomy and with the removal of cortex, but afterwards as well. A little of it may also become organized, causing permanent after-cataract and synechiæ. The bleeding is to be more carefully guarded against in intracapsular extraction, since here the blood cannot well be washed away. Still, these are not very serious matters. Also may be mentioned as a slight drawback (3) the difficulty experienced in outlining the flap exactly as one wishes. (4) After operation the *separation of the lips of the deep wound,* which takes place under a too complete conjunctival covering, presents very decided disadvantages to set against the advantage already claimed, namely, the value of this separation as a safeguard against secondary glaucoma.

This separation of the deep wound margins may be responsible for (a) permanent astigmatism, occasionally considerable in amount; (b) of such accidents as sometimes happen to eyes that pass through a prolonged low-tension period; and (c) the occasional, late, gradual incarceration or prolapse of the iris in a wound gaping under the conjunctival flap, seen by the writer especially after combined extraction. This occurrence, is however, too infrequent, even with a very extensive conjunctival flap, to greatly qualify the statement just made about the use of the flap as a preventive of prolapse. Moreover, this late prolapse, always small, is removable without any particular risk or difficulty. And all of these drawbacks apply only to a covering left considerably larger

[58] I question the power of any hemostatic solution to *arrest entirely* the flow of blood from the cut ends of the sclero-conjunctival vessels. I have employed, with the conjunctival flap incision, almost every form of these valuable adjuncts and find that, while they assist the hemostasis, bleeding into the anterior chamber is not uncommon, sooner or later, after the con-conjunctival flap is made.

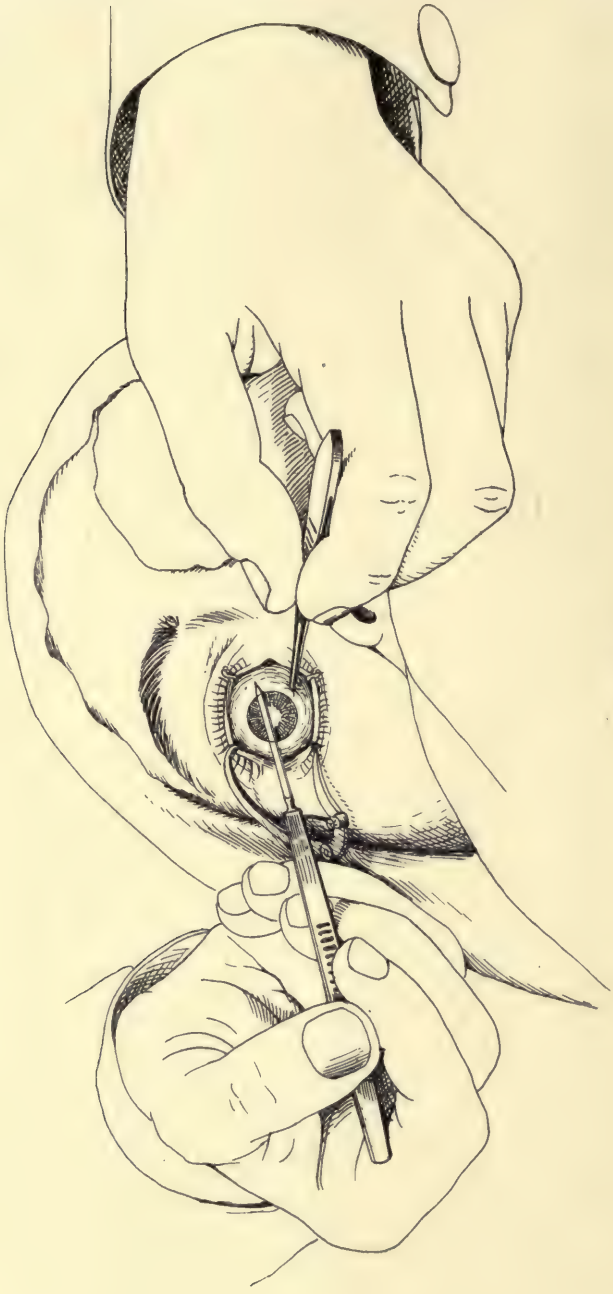


Fig. 581.

Senile Cataract Extraction on the Right Eye. The Counter-puncture has been made and the knife is being *thrust* or *pushed* firmly forwards and upwards to make most of the limbus section on the nasal side.

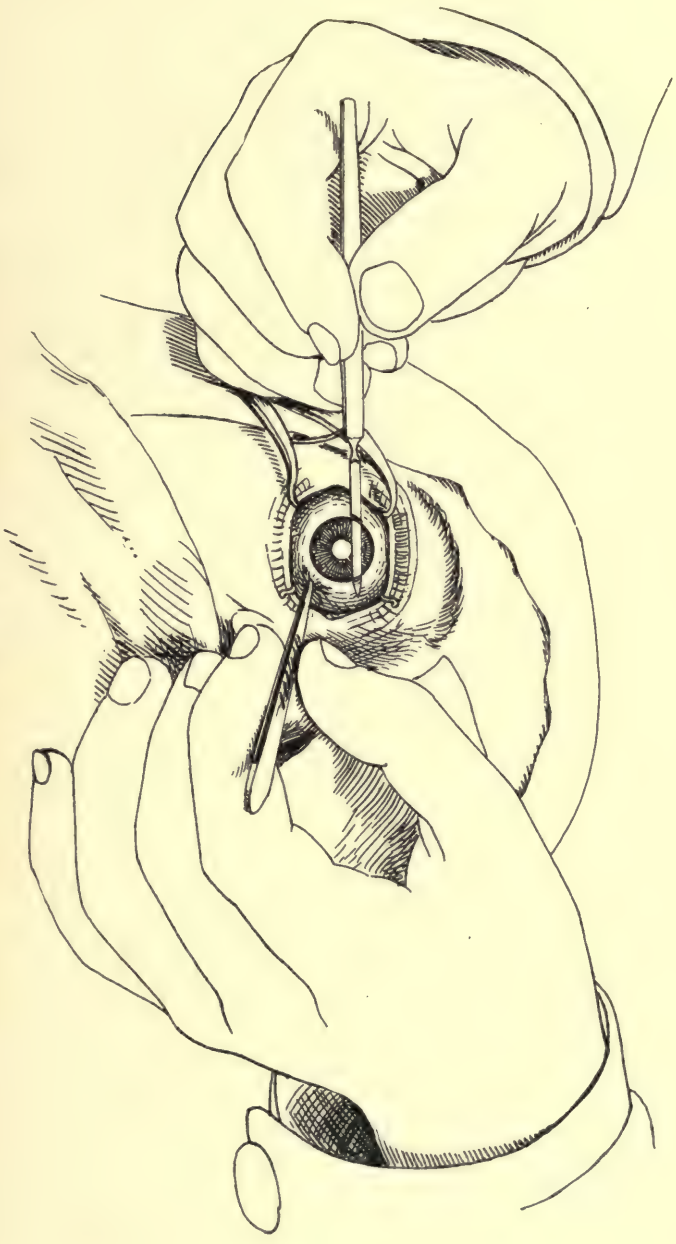


Fig. 582.

Senile Cataract Extraction on the Right Eye. (Continued). The Knife Handle is being *pulled* away from the Globe—at the Same Time being *pressed* gently upwards—so as to make most of the section on the temporal side.

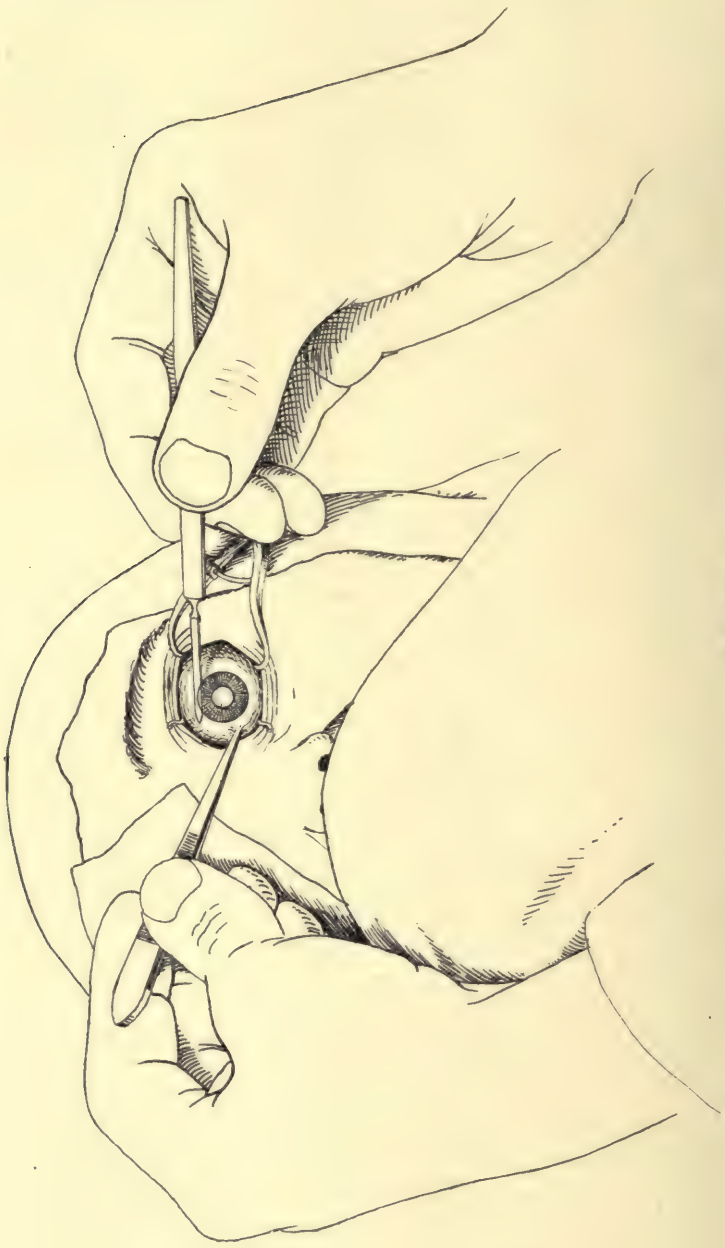


Fig. 983.

Extraction of Senile Cataract, Left Eye. (Continued.) The Last Stage of the Section. Forming the Conjunctival Flap.

than necessary. They can be avoided by trimming the flap, except where the vitreous presenting in the wound renders this inadvisable. (5) Very rarely the flap fails in its purpose through becoming folded down over the cornea.

To this experience of Herbert may be added that of C. F. Clark,[59] who thinks that a conjunctival flap does not increase, but on the contrary, diminishes the amount of the operative astigmatism.

The *advantages of the conjunctival flap* in the simple operation are thus set forth by Santos Fernandez:[60] 1. The bandage can be taken off in 48 hours. 2. There is less operative reaction. 3. Complete absence of photophobia. 4. Offers greater resistance to the pressure of cortical remains. 5. Covers completely the corneal wound and thus avoids infection through it. 6. Absolutely avoids prolapse of the iris, or anterior synechiæ. 7. In case of vitreous prolapse the eye is guarded against infection and this grave, at times unavoidable, accident is

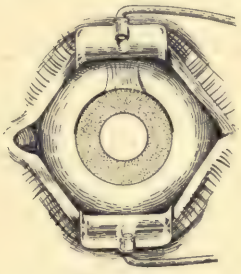


Fig. 584.

Diagram Showing the Relative Positions of the Corneal Section and the (Small) Conjunctival Flap.

less harmful than before. 8. In private practice it does not bother the patient and in hospital practice shortens greatly his stay in hospital, as he can be discharged on the fourth day and only routine precautions need be taken.

At this stage of the operation the fixation forceps is usually removed, but if the patient be a "good" one the speculum is permitted to remain in place. If, however, there is any doubt as to whether the patient will attempt to "squeeze" his lids together it is better to remove the blepharostat and support the eyebrow, as previously directed.

If the section be made in the manner mentioned the margin of the iris will not fall in front of the knife. Should it do so it is best to proceed with the operation as just directed, although a certain "scalp-

[59]Clark. Astigmatism after Cataract Extraction as Modified by the Conjunctival Flap. *Ophthalmology*, July, 1905, p. 605.

[60]Fernandez. (Personal Communication.)

ing" (iridectomy) will result. The methods commonly employed to prevent or obviate this accident will be considered later.

If the incision has followed the sclero-corneal junction and a conjunctival flap has been made in this way there will probably be some bleeding which the adrenalin does not entirely prevent. Should this be produced it is better to wait a moment or two, gently flushing the eye with warm boric acid solution and endeavor to soak up the diluted blood with a damp, cotton sponge. During this process the patient should be quietly told that "everything is all right," and "that the operation will soon be over."

The flap of conjunctiva should now be turned or pushed over upon the cornea with the closed iris forceps or a spatula. I am in the habit of applying to the surface thus exposed a single drop of a mixture of adrenalin and cocain.

The Iridectomy.

If the operation is on the right eye and all the usual indications of a favorable form of cataract be present, I endeavor to complete the removal of the opaque lens without operative interference with the iris; otherwise, and in the majority of cases, I prefer to do an iridectomy.

In that event it is well to notify the patient that he may now experience a little discomfort but that he must under no circumstances "squeeze up" his eyes but bear with just a little momentary pain. The surgeon should again ask him (always in a very quiet and low voice) to look down and keep both eyes, hands and mouth open. Then, holding the iridectomy scissors, closed, with the right thumb and middle finger and a pair of small iris forceps (also closed) with the left hand I introduce the forceps into the anterior chamber. When the point of the forceps reaches the margin of the iris, the jaws of the instrument should be opened and the iris grasped at this point. Then, by gentle traction, the forceps are withdrawn until the pupillary edge of the iris appears well outside the corneal incision. At this moment the folded iris tissue is cut through with one snip of the scissors held exactly in the vertical meridian of the cornea. If this step is properly carried out the margins of the coloboma thus formed will recede within the anterior chamber. If, after waiting a few moments, there is no disposition on the part of the iris to do so, it would be well to replace it, either by gently stroking the cornea with the back of a spoon, or by the employment of the iris-repositor— a performance already described by Alt.

Opening or Cutting the Capsule—Cystotomy.

The surgeon now takes in his hand the cystotome and introduces the point of the instrument (which should always be *quite sharp),* with its cutting edge backward into the anterior chamber. Of all the

forms of cystotomy that I have made use of I prefer the following: The back of the instrument is directed beneath the iris at the lower end of the vertical meridian. When the point reaches that position it is given a half turn so that the cutting edge is engaged upon the periphery of the anterior capsule. A firm and steady scratch is made, by the withdrawal of the handle of the cystotome, in the direction of one or other margins of the coloboma. The point of the cystotome is now disengaged and again introduced, as in making the first cut, and once more entered at or near the first point of capsular puncture. A second scratch is made, in precisely the same manner, towards the opposite margin of the coloboma. The upper points of these two incisions are now joined by a third scratch with the point of the cystotome which is further extended, until it involves nearly the upper half of the periphery of the capsule. Although this incision seems a complicated one, yet it generally combines the virtues of a partial capsulectomy with forceps and the best form of capsulotomy. Not only does it afford an admirable chance for extruding the lens proper but a portion of the anterior capsule corresponding to the pupil is almost always dislodged with the cataract.

Expulsion of the Lens.

The delivery of the cataract is a very important step in cataract extraction, because most of the ordinary accidents attendant upon the operation occur during this act. The best results in average cases are obtained by the use of two spoons, one placed on the inferior aspect of the globe *well below the sclero-corneal junction,* and the other laid on the upper margin of the wound behind the incision. The patient is told to look downwards and the *lower spoon is pressed firmly and steadily in one spot towards the geometrical center of the globe.* It is not well to exert too much pressure upon the posterior lip of the operative wound, although it should be kept slightly depressed below the margin of the oncoming lens. After a little pressure the cataract engages in the incision and by keeping up the same pressure above and below the lens will pass out without difficulty. This is a critical moment and the patient should now be warned to keep on looking down and still to keep hands, mouth and *both* eyes wide open. As the lens enters well into the wound the lower spoon should gently and steadily follow it and an endeavor should be made to preserve the same relations in distance between the lower edge of the cataract and the margin of the instrument. Wilder advises gentle stroking of the cornea at this moment so as to gather all the cortical substance possible in front of the lower spoon and about the lens and, then, with one sweep deliver the nucleus and cortex together. In this way the maximum amount of soft matter can be removed at the most propitious time.

In dealing with every lens—whether its passage is easy or difficult—one should try to expel it as nearly as possible *en masse*, avoiding, meanwhile, rupture of the zonula—an accident likely to happen if too much, or undue, force is employed.

Some difficulties in the delivery of the lens may also arise from *too small a corneal section*. This complication occurs with a badly made incision, especially when the deep wound is smaller than the superficial one. It may also arise when a broad flap is made after the extraction of a lens with a hard and large nucleus.

Then, again, the capsule may be *insufficiently incised*, or not opened at all. The surgeon generally discovers this failure when, on pressure, he finds that the lens moves slightly but makes no actual progress towards a complete exit. In that event, a very sharp cystotome should be used a second time.

As mentioned before, the capsule of Morgagnian cataracts is extremely difficult to cut even with a proper capsulotome.

Difficulty is to be expected with *very opaque capsules*, especially when they present a large, white, dense, circumscribed opaque area. Having been forewarned by these appearances the surgeon will employ a very sharp cystotome, using cautiously a little more force than usual, tearing the capsule if needed.

Should vitreous escape *in front of the lens* and the latter sink backward into the vitreous the best plan is to finish the operation by means of a wire loop or vectis. This procedure does not necessarily increase the vitreous loss.

Herbert (*loco cit.* p. 126) thinks that rupture *below* the lens is much less likely to give trouble than when it is ruptured above. In the former instance there is a tendency to displacement of the lens upwards so that depression of the upper margin of the wound is imperative before expulsion is attempted.

As soon as the lens is delivered the speculum should be removed, if this has not already been done. There now remains the removal of all the cortical matter, blood clots, tags of capsule and other debris.

Expulsion or Removal of Cortical Matter.

Unfortunately, it is impossible to determine exactly how much of the cataract or its capsule remains within the eye, because portions of these tissues are often invisible. My routine plan, when I suspect from the appearance of the expelled cataract, or for other reasons, that cortical matter is left behind, is, first, to make an attempt at "milking" or *gently* pressing out (by upward stroking of the cornea) as much as possible of these remains by the use of one or other of the spoons employed during the expulsion of the lens. Then I employ some form of intraocular irrigation. Although I occasionally use the regular Lip-

pincott irrigator, I am generally satisfied with a glass tube provided with a curved lip about 3 mm. wide and one mm. thick. This is attached to a bulb about 3 inches in diameter. This small instrument can easily be sterilized and is very effective in removing cortical matter, washing out blood clots, capsule tags, etc., from the anterior chamber. It is rarely necessary to introduce the point *into* the anterior chamber. By carefully depressing the posterior lip of the wound and engaging it barely within the incision a return current can be established on pressing the bulb so that lavage of the chamber may be accomplished almost as well as, and with fewer risks than, attends the use of the Lippincott or other form of intraocular irrigation.

Whether we wash out the anterior chamber or not, a simple, but at this stage of the operation exceedingly useful, procedure is the removal, by means of a spoon, spatula, iris repositor, or similar instrument, of all the foreign bodies from the wound-angles and along the line of the sclero-corneal incision. The point of the instrument is entered at one angle of the wound and carried to the opposite side.

The whole length of the incision should, finally, be closely examined with a lens for the purpose of detecting and removing any lenticular shreds, pieces of capsule, iridic pigment, vitreous beads, or minute blood-clots, that have escaped the earlier inspection. When even very small tissue shreds are allowed to heal in the wound, they are prone to attach themselves also to the iris, to the posterior capsule, or to floating bodies left in the anterior chamber, and so greatly mar the final result. Not only that, but they establish a communication between the interior of the eye and the outside world, and thus sooner or later become the means of infecting the delicate parts within.

Knapp and others have warned us of the *danger* which attaches to *massage of the cornea with the finger and lid-edges* in attempts to remove any of the anterior-chamber contents. The free borders of the lids are the parts of the external ocular apparatus most difficult to sterilize and most crowded with pathogenic microbes. It has again and again been demonstrated bacteriologically that the palpebral edges remain infected long after the surrounding skin has been rendered fairly sterile. The cilia perform for the conjunctiva much the same office that the vibrissæ do for the nasal mucosa, and the number and variety of bacterial colonies planted upon the free borders of the alæ nasi closely resemble those which we find infesting the skin about the eyelashes. Consequently, to rub, ever so lightly, the free edge of the lid over the freshly made wound in the cornea, is to invite infection of the latter.

If the patient is unreliable I believe there is danger in the employment of *any* intraocular irrigator.

During this procedure the assistant generally holds the lids apart

by means of retractors although these are not always necessary. The removal of the cortex is of great importance and it is better to run a little risk at the time of the operation than to have to deal with irritative iritis and secondary cataract after the healing of the corneal wound.

The subject of irrigating the anterior chamber will be further considered, both in this chapter, under Minor Surgical Procedures and elsewhere.

Immediate Treatment of the Sclero-Corneal Incision and Conjunctival Flap.

The conjunctival flap is now carefully replaced from its position on the cornea and, so far as possible, the lips of the wound are brought well into apposition. All loose debris should be coaxed from between

Fig. 585.

The Simple Anterior Chamber Irrigator Ready for Use in the Extraction of Immature Cataract.

Fig. 586.

Anterior Chamber Irrigator for Use in the Extraction of Immature Cataract.

the lips of the wound by means of pencils or "dabs" of moist cotton, assisted by a flow of warm boric acid solution or normal salt solution from the irrigator just described. One may supplement these efforts by the use of small iris or other forceps to drag out *with due care* such cortical and other remains as are not removable by gentler means.

Finally, when all this is done, or previously, the blepharostat should be removed and the lids allowed to close. This last act is best accomplished by drawing the upper lid up, and asking the patient to look down. The upper limb of the speculum is now easily disengaged. Then gently drop the lid upon the globe so that its edge falls well below the

conjunctival flap. The lower limb of the blepharostat readily follows as the patient *is told to look up.*

The patient is now informed that everything is over and there is nothing further to be done except to have a bandage over the eye. I at this juncture, usually ask the patient whether he would like one or both eyes bandaged, telling him that in any event I wish him to keep them both *closed most of the time* for the following 24 hours. By making this a matter of the patient's choice it assists him to bear up for an important period following the operation. Moreover, if he is allowed to open his eyes, but knows that it is *better* to keep them closed, he will probably choose the latter horn of the dilemma and not take much of the liberty extended to him.

If it be desired to affect the eye with drugs of any sort, now is the time to use them. It was once almost the universal custom to instill a one per cent. solution of eserine, when the simple operation was chosen, for the obvious purpose of contracting the pupil and so preventing prolapse of the iris. But as neither mydriatics nor myotics have any appreciable effect upon the muscular fibers of the iris so long as the anterior chamber is empty, this procedure has been pretty generally abandoned.

A decided mydriasis may, however, result from an instillation of atropine, even two or three days before the anterior chamber has reformed, just as soon as it is again refilled. If applied at all, I am much in favor of employing these remedies in the form of ointment, smeared on the lids or on the dressing. Not only is a drug applied in this manner more uniform in its action, but it is decidedly more persistent than when exhibited in solution. Moreover, one also obtains the soothing effects of the greasy application to the lid-edges, preventing their adhesion if much mucus is formed beneath the dressing, and allowing a ready escape for tears and other discharges.

Before removing the patient from the operating table it is well to explain to him what he may expect during the following day or two. I generally tell the patient that, while I wish him to keep quiet and talk little, he will not have to stay in bed very long; that I shall allow him to lie either upon his back or upon the side opposite the eye operated on, and that very soon he will be permitted to sit up in a chair. He is warned against making any sudden movements, is cautioned against straining himself in any way, and advised not to touch his eye or allow anything to press against it. He is also informed that a nurse will be at hand to answer any question that he may ask, and that he is to go to sleep at the usual hour.

Beard's Cautions.

In his admirable work on *Ophthalmic Surgery* Beard has appended

to his description of cataract extraction a number of negative suggestions and directions under the caption of "Don'ts," which I take the liberty of quoting. I strongly advise every student of the cataract operation to read and digest them.

"Don't get shaky. Pick up the knife, make a few finger movements with it and, if the hand is turning craven, just call a slight halt, resort to a little inward discipline, and one can usually regain his composure. A colleague once told me that when he found himself becoming demoralized on the eve of an operation, he walked to the window and, while apparently taking in the view, proceeded to give himself, mentally, a sound castigation, with the invariable effect of restoring his calm.

Don't drop cold or hot liquid into the eye during or after the operation—have it lukewarm. Don't let it fall from a height onto the eye and lids, as all tends to produce wincing. Don't squirt nor fire solutions *at* the eye, but pour them gently over it, and always warn the patient of your intention. Don't permit sponges to touch the cornea and disturb the epithelium.

Don't begin the instillation of the cocain solution until it is known that the operation can follow in not more than ten minutes. Don't let the speculum fly out of the fingers like a jack-in-the-box while in the act of putting it in position. Get a good, firm grip on it.

Don't pry the lids too far apart, for it induces spasm of the orbicularis and increases intraocular tension. Don't allow the speculum to rest heavily upon the globe. Don't fail to lift it away from the eye, and with a firm grasp, in removal.

Don't use fixation forceps that have a catch, and don't forget the hand that holds the forceps while fixing the eye. Don't rotate the eye with the forceps as if it rested with its posterior surface on a transverse vertical plane, but as it is, like a ball that turns on a universal central pivot.

Don't seize merely a fold of conjunctiva by which to steady the eye, but in addition, as much as possible of the subjacent tissues and as near as practicable to the cornea. Don't employ fixation after the bulbus is opened unless the need is urgent.

Don't neglect to test point and edge of both knife and cystotome before they are disinfected, to see that they are sharp. Don't use a knife with long, needle-like point—the tip might break. Don't hold the knife so tightly as to cramp the fingers, nor yet so loosely as to cause wavering. Don't attempt either corneal or capsule incision free hand. No matter how steady the latter, always rest the little finger on the patient's face, not only for support, but in order to move *with him* should he stir.

Don't haggle, fuss, nor hesitate in making the section, yet, while forging steadily ahead, do so with a certain deliberateness. Faulty sections, premature escape of aqueous, etc., come not so often of slowness as of vacillation.

Don't lose sight of the patient's demeanor. If this be favorable throughout the corneal section, it is apt to be so for the entire operation. If he begins to squeeze, pause, even though in the midst of the incision, and remonstrate with him in a kindly tone, and have the assistant guard closely the brow and speculum.

Don't take the eyes off the site of the operation *for an instant*. Have the assistants so trained that it will not be necessary for the operator to seek instruments and implements, nor to lay them down. Be in the closest touch with the subject, allowing not a single break in that subtle, intuitive current whereby we anticipate a move on his part.

Don't crawl all over the capsule and zonule with the cystotome. Take pains to place the point properly on the cataract just where the opening should begin—not hastily; elevate the handle until the point is sure to have engaged the capsule, then draw it very lightly along, making a definite cut, and note that the lens responds to the liberation by springing forward. If not, it is better to go over it a second time, there and then, trying to improve upon the first effort, than to be obliged to again enter the instrument.

Don't triturate the cornea too much with the spoon in delivering the cataract, nor rub it about in an aimless sort of way to get out the cortex. Be sure that the *back* and not the edge of the instrument is applied. Don't

stop to pick up the extracted lens unless it is caught deftly upon the upper spoon—merely brush it aside until the operation is terminated.

Don't have the instruments dripping wet, as the liquid, streaming downward, carries bacteria from the fingers to the eye. Don't hold instruments in the mouth to disembarrass the hands. Give them to an assistant or lay them down.

Don't talk any more than necessary, and never with explosive aspiration, to emit showers of germs, even though mouth and nose be covered by a mask.

It is the better part of wisdom to close and bandage the eye as soon as practicable after the extraction of the cataract, and to discourage all unnecessary movement or turning of it. With this in view, little exhibitions like having the patient count the operator's fingers or to tell the time on a watch, through a convex lens, it is deemed prudent to omit. Such things were formerly supposed to be a test as to whether any portions of the cataract were left behind, but as such the performance is a delusion."

Post-Operative Dressings in Cataract Extraction.

This subject is fully treated by Dr. Ellett in this *System,* but it may in addition be said that the simpler the application the better. This assertion is made because the patient's *comfort* from this time on is a *sine qua non* and those applications that are comfortable to him, that permit him to sleep, and that do not require too frequent removal are generally to be desired.

The so-called "triangular" bandage is the one that I have used as an immediate post-operative dressing for many years. It is made by placing a thin, uniform layer of sterile cotton wool between two thicknesses of gauze and then cutting the three layers into a circle which shall slightly overlap the orbital margins. Before applying this covering to the eye I draw down the lower lid and introduce into the sulcus a very small quantity of White's ointment. This serves to keep the lids from adhering and acts as a mild antiseptic.

Place the circular dressing, previously smoothed out, upon the eye. Two strips of adhesive plaster (made with zinc oxide so as not to irritate the skin) are attached along the eyebrow and nose; a third piece at the outer margin of the orbit completes the triangle. This bandage is light, porous and eminently satisfactory. It never gets out of place and does not unduly press upon the eyeball.

Removal of the Patient to His Room.

In the presence of the patient I warn the orderlies or hospital assistants to be careful in lifting him from the operating table to the stretcher and to avoid collisions with walls and doors in the transit to his room. Either the nurse in charge or a house surgeon is expected to attend the patient on this journey and to see that he is comfortably placed in bed. It would be well if the surgeon were also to visit the patient before leaving the hospital.

I am not in favor of keeping cataract patients in a dark room. I allow a certain amount of light to enter and permit the use of a lamp provided with a proper shade.

I generally prescribe an old-fashioned mixture containing 1.50 grammes of potassium bromide with 0.5 gramme of chloral hydrate half an hour before the time the patient usually goes to sleep. The interne should be warned as to the possibility of vesical retention and should inquire into the condition of the bladder while making his evening rounds.

The After-Treatment of Cataract Extraction.

The post-operative management of cataract extraction has been fully considered in Dr. Ellett's chapter, but I may add to it that the methods employed by me some years ago[61] are mainly those that I still make use of.

Shields and Masks as Protectives After Cataract Extraction.

What can be more provoking to the surgeon than to find, after obtaining a good operative result, that a careless nurse or a restless patient has added a newly-opened corneal wound, a hernia of the iris, or

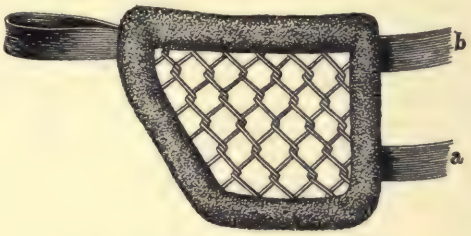


Fig. 587.
Fuchs' Wire Cataract Shield.

loss of vitreous, to his other anxieties? A finger-thrust, a pillow-end jammed into the eye, a slight blow upon the globe, or any other of the dozen little accidents that happen to a person with imperfect vision moving about in darkened rooms, may nullify the most brilliant and correct efforts of the operator.

Especially when night comes on, or when the patient begins to move about, the eye should be protected from injury by some sort of a shield or mask. Fuchs uses the wire-woven protector pictured in Fig. 587, and introduced as long ago as 1883. There are many modifications of this mask in the market, one of the best of which has been the "base-ball" mask suggested by Würdemann.

Certain operators who make use of the roller bandage gain protection by starching the dressing. When this has dried, the eye will receive a considerable blow without injury.

Snellen has used a turtle-shaped aluminum shield, about ten centi-

[61] Wood. The After-Treatment of Normal Cataract Extraction. *The Therapeutic Gazette*, Feb., 1896.

meters long and five wide, placed over the eye and held in position with strips of adhesive plaster; it forms an admirable protector.

One of the best shields I am acquainted with is the *papier maché* half-mask (Ring mask), which when carefully adjusted to the nose and surrounding parts makes a light, comfortable and effective protector.

A small proportion of patients object to wearing any sort of mask, claiming that it prevents them from sleeping and makes them nervous. In such cases I find that one may get along very well with a large, stiff and very concave eye-shade placed over the dressing and held in place with a piece of rubber plaster.

I am in favor of always removing the bandage and looking at the

Fig. 588.
Würdemann Base-ball Cataract Shield.

eye twenty-four hours after the extraction. The corneal wound is now either altogether healed over, especially if a conjunctival flap has been made, or if not the danger of prolapse of the iris has generally passed. That is to say, if no iridic hernia has occurred at the end of twenty-four hours, it is not likely to happen at all from any cause, except from violent sneezing, coughing, direct traumatism, etc. In cases of uncomplicated cataract-removal the lids at the end of twenty-four hours are not discolored or edematous. From a glance at them, one can generally predict the condition of the eye beneath. The discharge on the bandage should be watery only (or contain little mucus) and ought not to be copious. The main object, however, of the inspection is to de-

termine the position of the iris. If prolapse has occurred, *now* is the best time to deal with it.

The eye should be gently bathed with boric acid solution, and any mucus, vaselin or ointment washed off the lids and cilia. This should be repeated daily. Solutions instilled into the eye must be neutral or slightly alkaline to test-paper, and always warmed.

When the corneal wound is healed and the anterior chamber re-established, the ordinary bandage may be dispensed with. I am in the habit of substituting for it a *concave* monocular eye-shade which, while touching the brow, cheek, and nose, is clear of the eyelashes. This is worn loosely over the eye during the day, and at night is kept in place

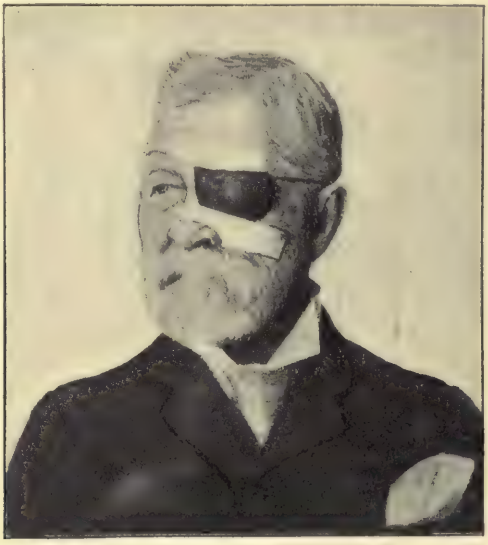


Fig. 589.
Concave Shield for Protecting the Eye After Cataract Extraction.

by a small strip of adhesive plaster, as in Fig. 589. In a week or ten days one may usually dispense with any dressing or protection whatever, particularly where the patient remains indoors.

The Period of Confinement of the Patient.

On what day should the patient be allowed out of bed? In all ordinary cases twenty-four hours is long enough for him to maintain absolute rest. Still avoiding sudden movements he may then be allowed to sit up in an arm-chair and even to move about in the room, and so gradually regain his wonted liberty. After forty-eight hours the bowels should be moved by an enema, and more solid food is added to the diet list.

Common sense will dictate when and under what circumstances the subject of cataract-extraction should be allowed to venture out of doors. If exercise be taken in a close carriage, he may, with the eye wearing an ordinary shade, be allowed out, even in severe weather, as early as the end of the second week; when the day is comfortably warm and there is no wind blowing, walks may be taken with impunity.

There should be absolutely no use of the eyes for a month, when glasses should be allowed for distance; when the patient is accustomed to these, lenses for near work may be prescribed.

THE INSTRUMENTS COMMONLY USED IN THE EXTRACTION OF CATARACT AND A FEW OF THEIR MODIFICATIONS.

The *modifications* of the usual instruments employed in the modern operation of cataract removal are quite numerous. I have already stated my own preference and refer the reader to Dr. Guilford's chapter on Ophthalmic Instruments for further information on the subject. Meantime, I propose to describe briefly not only the forms that I prefer but a few others that are in common use in this country.

Testing Instruments.

Priestly Smith[62] has invented a balance for testing the sharpness of cutting instruments (q. v.) that is described in Dr. Guilford's chapter. Any device that assists in accomplishing those necessary desiderata, viz., clean, polished and *very* sharp knives, lances, scissors and needles, is devoutly to be wished. It may not take the place of a magnifying glass and the ordinary kid drumhead but may at least be used in conjunction with them. It is just as essential that the operator know whether the cutting instrument he is about to use is *sharp* as that it is clean.

The Speculum and Blepharostat.

Some device—the simpler in form the better—is generally employed to separate the lids during the operation, or until the corneal section is completed. For many years I have used the gold-plated Clark speculum, made by Weiss, of London. I do not like the "stop" or catch attached to most of these instruments, so I have that appendage removed and the result is a strong but light, easily adjusted blepharostat whose spring maintains for years just enough force to increase the interpalpebral space to the utmost without pain or even discomfort to the patient. The absence of the stop enables the operator to remove the instrument in an instant and at a moment's notice.

It was Sharp who first (in 1753) pointed out the probable value of the blepharostat. "I should not be surprised," he said, "if *the use of a*

[62]Smith. Balance for Knife Testing. *Ophthal. Review*, Aug., 1903, p. 211.

speculum oculi should hereafter be esteemed an improvement. But, then, it must be contrived so that it shall not compress the globe of the eye; or, if it does, the operator must be careful to remove it in the instant the incision is making, lest by continuing the pressure after the wound is made, all the humors should suddenly gush out."

Fixation Instruments.

There are numerous instruments for keeping the eye quiet and in position, but whatever form they may take they should have stout but not too heavy blades. The latter ought not to be too long, and they should be without a catch. The spring of the forceps ought not to be too strong, else it will tire the fingers of the operator or assistant. Above all, while the teeth should be sufficiently sharp to grasp the tissues they should *not* be needle-pointed, as they often are, otherwise they will cut through the conjunctiva and make a nasty wound. There ought to be three teeth in one blade and two in the other, and one set should fit accurately into the other. As a rule, these instruments are

Fig. 590.
The Clark Speculum.

made too long and really embarrass the operator; it is not necessary that the handle of the forceps should project several inches above the hand that holds it.

The Angelucci Fixation Method.

This surgeon[63] rotates the eyeball downwards and seizes with strong fixation forceps the tendon (with the overlying structures) of the superior rectus. By this means the globe is not only perfectly fixed but the upper lid is held out of the way. In sunken eyeballs, or when the patient attempts to squeeze the lids together or to rotate the eyeball upwards, these efforts do not cause gaping of the wound. Moreover, the grasp of the forceps can be loosened in an instant at any critical moment during the operation and the lids closed at once. This method is very useful in several forms of cataract and is extensively employed. It is illustrated in the text by drawings from the author's original paper.

---

[63]Angelucci. Una Modificazione al processo di Estrazione semplificata della Cataratta. *Archivio di Ottalm.*, Vol. V, fasc 3-4, p. 6.

The Corneal Knife.

In the ordinary operation the well known Graefe knife is employed—an instrument too popular to require description.

Although many operators prefer aluminum or steel handles I am much in favor of ivory. The last-named material is not too heavy, does not get slippery when wet and stands various sterilizing processes quite as well as metal. Nickel-plated handles in particular become rough and soon lose their polish. The blade of the Graefe knife should have a well sharpened, almost needle-like point and should not be too broad or too long. For the average cataract extraction I prefer medium-sized knives, although there is considerable variation in the choice of these instruments among ophthalmic surgeons.

Edward Jackson,[64] in the hope of discovering a knife that would combine all the advantages of Beer's instrument—single, forward thrust, smooth incision without angles, and no intermission in the corneal resistance—devised the knife pictured in the text.

Fig. 591.

Angelucci's Superior Rectus Fixation of the Eyeball.

During the Corneal Incision. During Delivery of the Lens.

It is an improvement on a former instrument, a description of which was published in 1888. The inventor describes it as follows:

The essential characteristics of the knife now presented are: The blade has a maximum width barely sufficient to complete the desired corneal section. The maximum width is reached 20 mm. from the point. At 10 mm. from the point fully two-thirds of this maximum width is reached. From the point to the 10 mm. line the edge of the knife is straight. From the 10 mm. line it begins to curve, so that at the 20 mm. line the edge is parallel to the back. The back is straight throughout. The blade is flat and is as thin as is compatible with sufficient rigidity and strength. Its outline is shown in the figure; the dotted lines indicate distances of 10 mm. from the point.

The particular width of the knife must be determined by the depth of the corneal section it is desired to make. The dimensions given in the figure are for nearly the maximum corneal flap of 4.5 to 5 mm. For a 3 mm. flap the maximum width of blade should be 3 mm. or a little less, and the width at 10 mm. from the point should be 2 mm.

By holding such a knife with its widest part in front of the cornea with

[64] Jackson. The Corneal Section for Cataract Extraction. *Trans. Am. Oph. Soc.*, Vol. IX, 1900, p. 147.

its cutting edge opposite the corneal margin, where the center of the incision is to come, the back will indicate quite accurately the points for the puncture and counter-puncture.

The knife is to be entered at the point for the puncture with its blade in the plane of the proposed section, and its straight back pointing toward the point for the counter-puncture, and then pushed steadily forward. In Fig. 593 the solid routine represents the position of the knife at the completion of the counter-puncture. The boundaries of the corneal section are shown by the heavy lines, the section of the external surface by the solid line, and of the internal surface by the broken line.

The back of the knife, by its counter-pressure, so balances the pressure of the cutting edge that there results only a slight tendency of the eyeball to rotate. This tendency is to turn in the direction of the forward thrust. It is best met by placing the fixation forceps just outside the limbus, close below the counter-puncture.

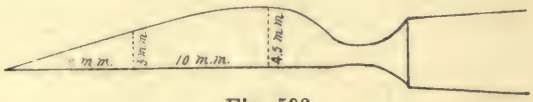


Fig. 592.
Jackson's Cataract Knife.

The forward thrust of the knife is continued until the section is completed, or until the widest part of the blade has fairly entered the cornea. If the section made is a smaller one than the knife is capable of cutting, it will be finished before the widest part of the knife has quite entered the cornea. If it be deeper than the maximum width of the knife, the end of the forward thrust, indicated by the broken line in Fig. 593, leaves a thin bridge of tissue undivided. This is best divided, as the knife is withdrawn, by rocking the knife about the point of puncture so as to complete the section with the part of the cutting edge near the point.

The Iris Forceps.

In spite of the great variations in this instrument I have held rather steadily to the Noyes pattern. It is an instrument easily handled, is small enough to be retained between the thumb and index finger

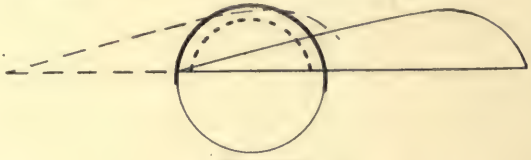


Fig. 593.
Jackson's Cataract Knife; Showing the form of the section.

and is more readily manipulated than long-handled forceps. I must repeat in regard to iris forceps what I have already said about the handles of the fixation forceps; *I do not see the purpose of having long handles in either case.* They usually get in the way and subserve no useful purpose that I have been able to discover. In any event the teeth—one male and two female—should fit quite accurately and they should be sharp and polished.

The Iris Scissors.

Although quite a few operators, perhaps the majority of the bet-

ter known ophthalmic surgeons, prefer to cut the iris with de Wecker scissors, I have never seen the advantage of that instrument, for this purpose at least, over the common form of half-curved iris scissors. Some operators use a pair of "elbowed" scissors for the right eye and straight scissors for the left, but I have been able to perform the operation using the same semi-curved (on the flat) instrument for each eye. Iris scissors should be well made, quite sharp, and be able *to cut easily and as well at their points as anywhere along the blades.*

Cystotome.

Of the dozens of instruments used for the purpose of opening the capsule, I have for many years adhered to the Graefe instrument, taking care that the point is *quite prominent and as sharp as a needle.* I believe it is well to have a different cystotome for each eye and that the shank be not bent too frequently in an attempt to adapt it to the various conditions met with. When bent at an angle of about 25 degrees it will be found quite adequate for all ordinary eyes.

Webster Fox[65] describes twenty samples of this instrument without, by any means, completing the list. They are pictured as figures in the text.

Iris Spatula or Repositor.

For stroking the cornea or for direct replacement of the iris I generally employ the flat side of a Daviel spoon, although in replacing the columns of a coloboma the flat iris-repositor is perhaps better. When used for reposition of the iris, the spoon should have a shallow, concave surface and its edges should be round and thick, while the body of the instrument should not be too broad. In this form it is an extremely useful instrument not only for replacing the iris but in using counter-pressure above the wound in conjunction with the Bowman spoon just referred to.

Instruments for Assisting the Delivery of the Lens.

I do not believe that anything better can be chosen for this purpose than spoons of the type of Critchett or Bowman. Modifications, as well as variations from this form of spoon are numerous and will be found considered in Dr. Guilford's chapter.

Anterior Chamber Irrigator.

The instrument I commonly employ is made of a small glass tube bent 3 or 4 mm. from its point to an angle of 25 degrees and provided with a mouth two or three mm. broad and a half mm. wide. This tube, about three inches long, is inserted and firmly tied to a rubber

[65]Fox. The Delivery of the Lens after the Extraction of Cataract. *Presession Reprint, Sec. Ophthalm., A. M. A.*, June 4, 1907, p. 57.

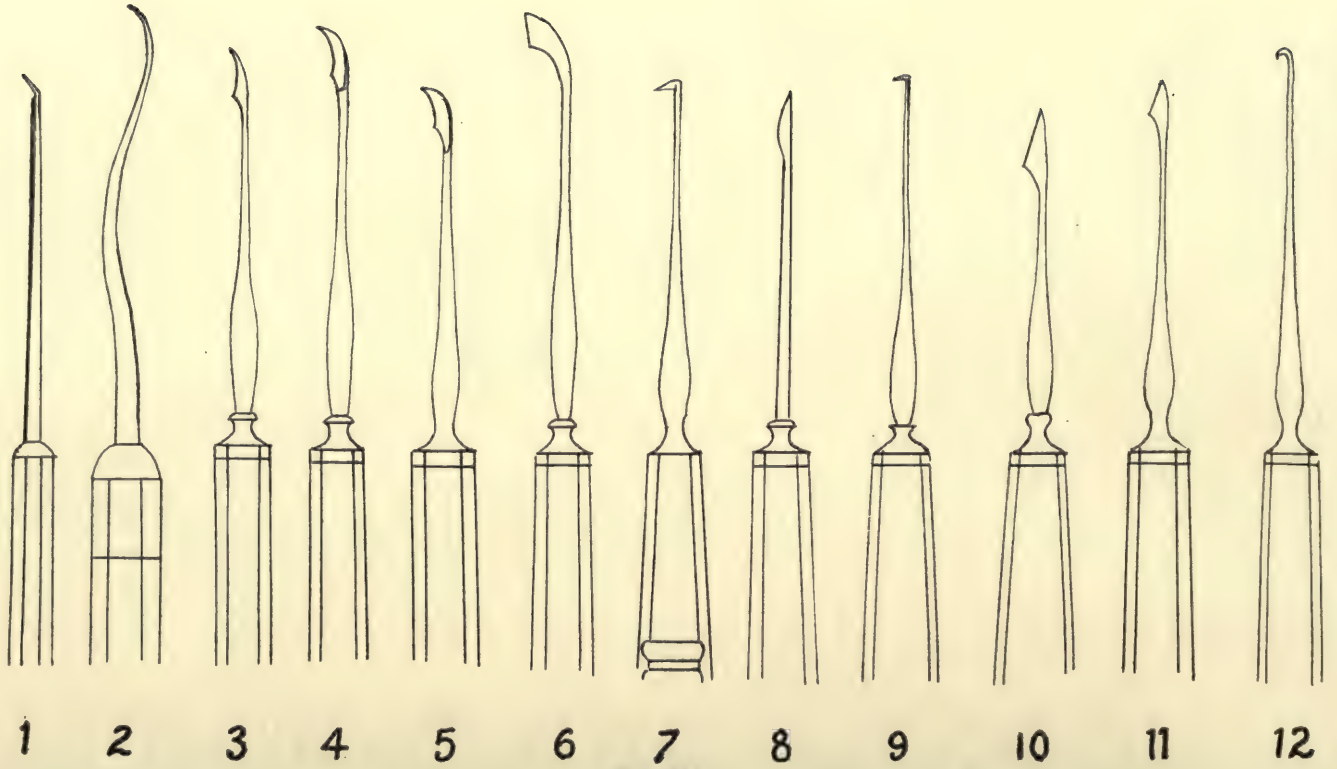


Fig. 594.

Cystotomes as used by: 1, Freytag; 2, Baron Wenzel; 3, Langenbeck; 4, Rosas; 5, Boyer; 6, Ritterich; 7, von Graefe; 8, Wardrop; 9, Arlt; 10, Desmarres; 11, Cusco; 12, Becker.

bulb holding about four ounces of fluid. The whole instrument is rigorously sterilized and cleansed immediately before using. It is carefully searched for the presence in the tube or bulb of rubber dust by ejecting some of its contents prior to irrigation. On some occasions I use the Lippincott irrigator which I find to be a very handy instrument.

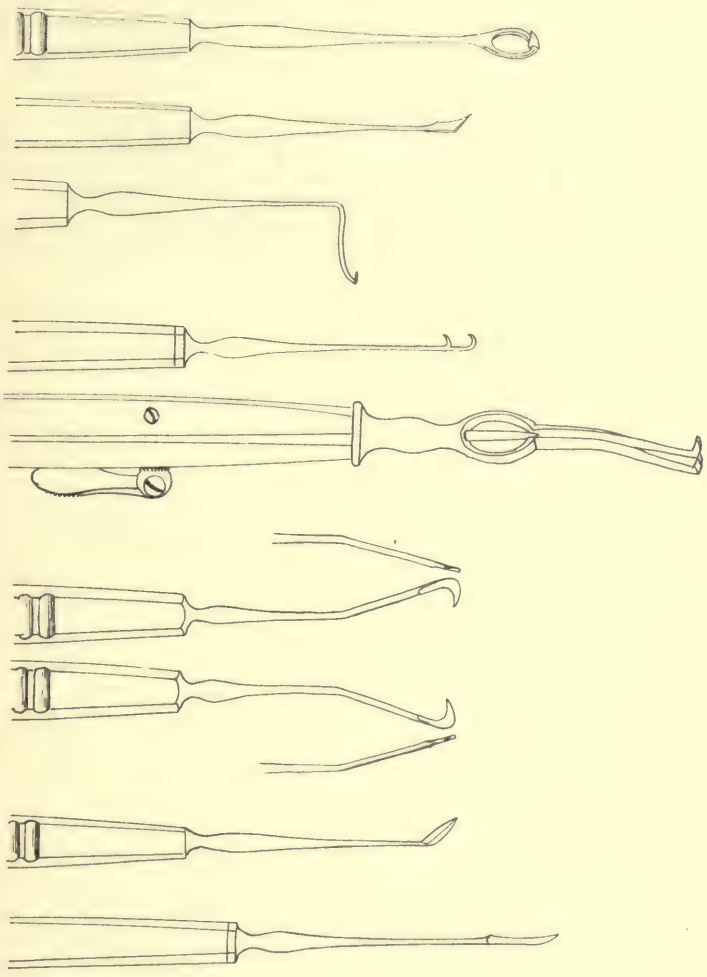


Fig. 595.

Cystotomes as used by: 13, Bettremieux; 14, Knapp; 15, Jaeger; 16, Weber; 17, Meyer; 18, Landolt, right and left; 19, Ziegler; 20, Galezowsky.

If resorted to at all, the greatest care and gentleness should be exercised in irrigating the eye after cataract extraction. Panas—who, by the way, abandoned the method which he was among the first to advocate—advised the use of a specially devised syringe (Fig. 596), the point of which is to be introduced between the lips of the wound,

and the anterior chamber flushed with one of the following solutions, which are to be *warm:*

Borax	gm.	4.
Boric acid	gm.	3.5
Hot sterile water	gm.	100.

Or,

Common salt	gm.	1.
Sterilized warm water	gm.	100.

Fig. 596.

Panas Syringe for Irrigation of the Anterior Chamber in Cataract Extraction.

Instead of using the syringe piston or bulb as the propelling force, sometimes prefer careful flushing the anterior chamber not only with the simple irrigator pictured as Fig. 597, but with the following apparatus: A pint bottle filled with the warmed irrigating fluid, and provided with a nozzle and stopcock at its bottom, is placed about four inches above the patient's head. Rubber tubing connects the bottle with the point of a Bowman's syringe. After the whole apparatus has been carefully cleaned of dust and sterilized, the syringe-point is placed within one angle of the operation wound, and the chamber is washed

Fig. 597.

Anterior Chamber Irrigator Made from Bowman's Suction Syringe.

out by a stream from the bottle. The process is repeated at the outer wound-angle until the pupil becomes black and the chamber clear and the iris coloboma edges are in place. The irrigating stream and the syringe point generally act as an iridic repositor.

SOME MODERN VARIATIONS IN THE TECHNIQUE AND INSTRUMENTS EMPLOYED IN CATARACT EXTRACTION.

It will, of course, be impossible to even mention all the numerous variants of the ordinary operation for the extraction of the opaque lens, but it is important, in a work like this, that the principal modern meth-

ods and most of the special instruments employed in carrying them out, should not be passed over.

Modifications of the Corneal Section.

These have already been referred to but there still remains something to be said on the subject. Daviel, towards the end of his career, made trial of a triangular corneal section outwards, which is described by Czermak,[66] and pictured in Fig. 569. The flap was divided into two parts, the first incision being made by an angular scalpel, the second with scissors. The incisions began at the outer margin of the cornea, one of them running upward and the other extending below, both touching the vertical meridian.

It is not possible to complete the sclero-corneal incision in one double movement of the blade without using too much force, especially in sunken eyes and in those with an unusually small interpalpebral aperture. When, however, it can be done, an incision by the smallest number of to and fro strokes is most likely to result in perfectly smooth and level wound surfaces that are more likely to unite firmly and evenly than are the edges of an uneven wound. Yet, it must be remembered that the degree of force necessary to complete the incision in a few moments may endanger a weak zonula, especially if a broad knife be used.

The Modern Section Downward.

Every now and then a surgeon of experience advocates the making of a section directed downward. Schweigger (Simple Extraction Downward, *Archives of Ophthal.*, Vol. 28, 3, 1898, p. 255), for example, advised this form of operation on the ground that the wound closes sooner and more perfectly than in the usual incision upwards. He used his (double) harpoon for the globar fixation, capsular forceps (when there was capsular thickening) and sometimes made an opening in the iris parallel to its insertion and near the limbus. Tropococaine was used to anesthetize the iris after the section. It was then pulled forward with fine forceps and punctured with a suitable knife. The puncture was afterwards widened with a broad needle. This opening served the purpose of a safety-valve in drawing off aqueous and debris and then closed (as a rule) with the healing of the corneal incision. He thinks that in following this plan vitreous loss and iris prolapse are capable of reduction to the minimum.

Galezowski made use of a pointed knife in the performance of Graefe's linear extraction, which he did in the sclera outwards. In the same way McNamara, Andrew and Castarina madè similar sections at the temporal margin of the cornea with a broad keratome and re-

[66] Czermak. *Loco cit.*, p. 329.

moved the lens, with a spoon, in its unruptured capsule. Castarina did the same operation, using a Beer's knife.

Bourgeois[67] made use of a double knife-needle[68] whose 1 mm. broad blades are parallel and in the same plane. The needles are locked by a simple mechanism which permits of their easy separation. With this instrument he makes simple extractions by a temporal, lateral section in cases where the application of sutures is indicated, where the palpebral aperture is small, in very prominent eyes and in totally deaf patients.

After cocainizing the eye the globe is fixed at one side, the ophthalmostat being held by an assistant. The puncture is then made at the sclero-corneal junction, one blade at either side of the horizontal corneal meridian, the knife being held in the right hand for either eye. At the moment of making the puncture the surgeon himself assumes the forceps with his left hand but gives it to the assistant immediately afterwards. As soon as the blades have penetrated well into the anterior chamber they are unlocked, the lower blade is held in position with one hand while the other is made to cut upwards along the corneal margin nearly to the vertical meridian. It is now withdrawn and a similar but downward incision is made with the other blade. In this way two half sections are made supported by a bridge of undivided cornea 1 mm. broad. The bridge of uncut cornea is now divided with a blunt-pointed knife, and the lens extracted in the usual way. Bourgeois suggests that the lens may be removed in its capsule after a preliminary division of the pupillary margin of the iris with scissors.

The sutures are then drawn tight and tied. They are left for five or six days. If necessary, to prevent prolapse or loss of vitreous, a third suture may be placed in the middle of the wound.

Müller's Corneal Incision.

L. Müller[69] also designed a corneal section to be used where the application of sutures seems necessary to guard against prolapse of the iris, or where there is reason to expect loss of vitreous. He first forms at the limbus a small superficial corneal flap with its base forwards. It measures 5 mm. from side to side and extends vertically about 2 mm. This incision is made by entering a narrow Graefe knife into the substance of the cornea, with its cutting edge downwards and without penetrating deep enough to enter the anterior chamber. The incision is now made downwards about 2 mm., when

---

[67]Bourgeois. Extraction Simple de la Cataracte Sénile par Kératotomie Latérale Externe et Sutures de la Cornée. *Annal. D'Oculist.*, Vol. 125, 1901, p. 10.

[68]Double knife, made by M. Major, 91 boul. Saint-Germain, Paris.

[69]Müller. Ein Operationsverfahren für komplizierte Stare und luxierte Linsen. *Klin. Monatsbl. f. Augenheilk.*, Vol. XLI, 1903, p. 11.

the edge of the blade is turned directly forwards. As will be seen in the illustration, this maneuver makes a small flap *a, c, d, b,* which is not thin at its extremity, but is cut at right angles.

Two sutures are now inserted at the angle of the blade, *c* and *d,* the loops being left quite loose. The section is now completed by an incision upwards, as in the usual 3 mm. section. After the extraction of the cataract the sutures are tied and left in position for one or two days. It would seem from a description of this method that the intricacies of the technique outweigh any possible advantage to be gained by the operation.

Schulek's Incision.

A method has been described by Schulek[70] that closely resembles a later *double flap section* invented by Plehn.[71] Both these procedures are intended to prevent prolapse of the iris. Schulek used a narrow Graefe knife; Plehn a specially made trapezoid instrument. After

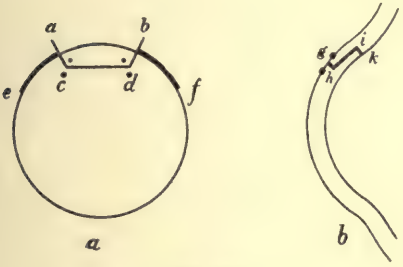


Fig. 598.
L. Müller's Corneal Incision.

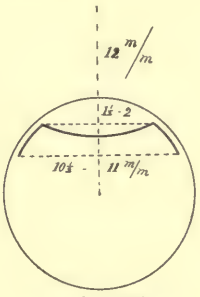


Fig. 599.
Schulek's Corneal Incision.

making the usual upward incision in the limbus for a portion of the distance, the section is completed at an angle downwards and forwards (see the figure). As a result of this incision, there is in addition to a large lower flap directed upwards a smaller, overlapping portion of the cornea projecting downwards. The lower flap is supposed to fit into the groove behind the upper and to be kept in place by it. It cannot be said that this complicated section has found many friends.

Extraction with a Lance-Shaped Knife.

J. H. Claiborne[72] employs a *keratome-like knife,* after the *plan of Daviel and Weber.* However, this operator's knife differs somewhat from that of his illustrious predecessors. Weber's knife is heart-shaped

[70]Schulek. Ungärische Beiträge zur Augenheilk., Vol. I, 1895, p. 254.
[71]Plehn. Ueber einen Extractionsschnitt in zwei Ebenen. *Zeitschr. f. Augenheilk.,* Vol. V, 1901, p. 259.
[72]Claiborne. Extraction of Cataract with a Lance-Shaped Knife. *Trans. Am. Ophthal. Soc.,* 1908.

and has a hollow back. *Claiborne's instrument is triangular and has a flat back,* so that the anterior and posterior surfaces occupy parallel planes—it, therefore, makes a straight wound—increases in thickness gradually from apex to base, and the handle rises from the base of the triangle exactly as in the regular lance-shaped keratome at present in use for iridectomy.

The length of the Weber knife is 10.25 mm., the one Claiborne describes is 8 mm. in length. The greatest breadth of his knife was 12 mm. at the base of the triangle; Claiborne's also measures 12 mm. at the base. Weber's knife was so constructed that at 6.5 mm. from the apex the breadth was 10 mm.; as he believed this width would insure the safe passage of a lens of 9 mm. in diameter, but it is questionable whether with so obtuse an angle the knife could be thrust into the anterior chamber at all. In support of this suspicion is his statement that in regard to the cutting qualities of his knife he had some complaints to make, but that later he was completely satisfied with the

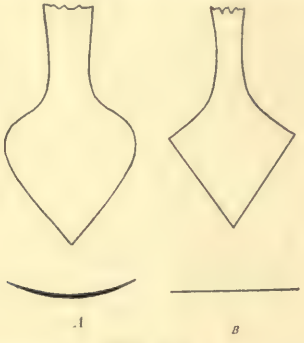


Fig. 600.

Claiborne's Lance-Shaped Cataract Knife and the Linear Section made by it as compared with Weber's (a) and his own section (b).

work of his instrument-makers. Claiborne's experience in that line leads him to doubt the efficiency of a heart-shaped knife which at 6.5 mm. from the point possesses a breadth of 10 mm. The angle is too obtuse for a stab wound to be made easily. The knife which Claiborne devised, however, enters the anterior chamber with as much ease as any of the lance-shaped keratomes he has ever used. The angle subtended by the point of the Weber knife is 73.5 degrees.

After performing his first operations Claiborne became convinced that he could use a knife with a broader base with greater certainty of success.

It will be observed that Weber estimated the depth of the anterior chamber at 12 mm., but Claiborne believes it to be still deeper, 13 mm. In view of these findings, he had Tiemann make a "final" knife with

a base of 14 mm., and a length up to the base line of 10 mm. It will be observed that there are about 2 mm. of blade above and beyond the base line, after the manner of the ordinary lance-shaped keratome; this gives the knife 2 mm. more length and insures the entrance of the point well into the lower iridic angle.

Claiborne believes that the time which elapses between the puncture and the completion of the Graefe section is fraught with danger at every second and it is a trial alike to the nerves of the patient and the surgeon. During this time, there is danger of too great pressure with the fixation forceps, of pricking the lid or nose by the point of the knife, of squeezing the lids and of general nervous misconduct on the part of the patient, with consequent destruction of the eye by loss of vitreous.

Claiborne employs his lance-knife as follows: The surgeon should stand behind the patient and a fixation forceps should be applied directly below the cornea opposite the point of entrance of the knife. The eye being rotated downward, the point of the knife is entered about 1 to 2 mm. behind the sclero-corneal margin in the median plane of the vertical meridian. The knife should then be shoved straight across the anterior chamber until its apex arrives at the limit of the inferior iridic angle, when it should be withdrawn slowly; a cutting motion to the right being made at the same time to enlarge slightly the size of the wound, if the operator thinks necessary. If the knife is withdrawn too quickly, aqueous escapes rapidly and the iris is apt to prolapse. Either the simple or combined extraction may be performed." Claiborne prefers the combined methods, as it renders the exit of the lens easier. Care should be taken to maintain the point of the knife in the same plane in which it entered. The section is executed within three seconds, and forms a marked contrast to the time required to perform the Graefe section.

The advantages of a section made by this knife are stated as follows: 1. There is no counter-puncture. 2. The section is made in the plane of the support furnished by the fixation forceps. 3. The wound is a stab-wound, and by virtue of that fact is smooth; no sawing motion is employed. 4. The section is practically finished by shoving the knife home. 5. There is no loss of aqueous while the section is being made, because the knife increases in thickness from the apex to the base, and the farther it penetrates in the tighter it stops the wound. 6. The iris is not so apt to prolapse on withdrawing the knife, because the broad back of the knife holds it in place. 7. The iris cannot fall before the knife from loss of aqueous because no aqueous is lost during the section on account of the shape of the knife. 8. Perfect apposition of the lips of the wound by virtue of its smoothness; rapid healing; less

liability to suppuration; less post-operative astigmatism. 9. Use of right hand for both eyes. 10. If the knife is entered properly and shoved home, the section is bound to be correct; it automatically commands success. 11. Less danger of prolapse of vitreous, because of the support furnished by the broad back of the knife. 12. Diminished time.

The Simple Versus the Combined Operation.

It would require many pages to discuss the merits and defects of the two principal methods of extracting senile cataract. Probably the proper form of inquiry should relate not so much to a decision as to which is the better method, but to an attempt to decide the cases in which one operation ought to be performed in preference to the other. In other words, a selection of cases is called for because it is undoubtedly true that one operator may employ the simple method too much.

The chief complication and, it might be added, the chief objection to the operation *without iridectomy* is the more frequent occurrence in it of iris prolapse and the difficulties in dealing with cortical matter. Both these drawbacks are associated with their attendant evils, uveitis, astigmatism, irregular pupil, secondary cataract, etc., and it is a question whether the simple operation should be done in every instance by one who has not had considerable practice in dealing with the complications that are most likely to occur.

I have already expressed my preference for the simple procedure in most cases of hard, mature cataract occurring in healthy, *right* eyes. On the left side, or in any case where there are deviations from what might be termed the normal type of senile cataract, I believe that it is wise to make some form of iridectomy.

The exsection of the iris does not materially differ in extraction of cataract from that done for some other purpose, except that it ought to be small and that the margins of the coloboma should be carefully replaced before the toilet of the wound is completed. The figures in the text sufficiently indicate the varieties of interference with the iris commonly employed as part of the combined operation. As is well known, the purpose of iridectomy is to lessen the probability of prolapse, glaucoma and post-operative infection. Inasmuch as the results obtained by operators will always vary to a large extent it is impossible to set forth all the advantages and disadvantages of an iridectomy in senile cataract extraction.

Czermak and Elschnig *(Die Augenärztlichen Operationen,* Vol. II, p. 453) give the following *advantages* and *disadvantages* of both operations.

The advantages of the simple operation are quickness and ease of procedure; the slighter trauma and the barrier to vitreous and ciliary

injection on account of the uncut iris; the cosmetic advantage of a round pupil; the optical advantages of the round, central pupil, because of the better visual acuity, orientation, and the screen-like effect of an intact iris; better healing of the corneal wound and, finally, the rarer occurrence of vitreous loss during an operation.

The disadvantages of the simple operation are as follows: The necessity for a larger corneal incision, which predisposes to infection and iris prolapse; further difficulties in extracting the lens and in expelling cortical and capsular remains; more frequent secondary cataract and the greater necessity for secondary operations; more frequent prolapse of the iris; the difficulty that *some* operators experience in performing this operation as compared with the combined extraction.

The advantages of the combined extraction are, easier removal of the cataract and cortical remains; a smaller incision and, consequently, less exposure of the wound surfaces to infection; less liability to prolapse of the iris; fewer chances of glaucoma and inflammatory reaction; a greater certainty of the results.

Among the *disadvantages of the combined operation* are greater probability of complication owing to the longer time required for the operation; wounding of the iris together with the pain and bleeding that attends it; the danger of minor incarcerations of the iris, with capsular remains in the corners of the wound, and of their sequels (cystoid scar, small staphylomata, iritis, irido-cyclitis and sympathetic ophthalmia); slight incarceration of the capsule; inferior visual acuity, diminution of peripheral sight and, in consequence, defective orientation; greater liability to post-operative glaucoma on account of iridic and capsular hernia.

However, the dictum of Terrien *(Chirurgie de l'Oeil,* p. 149) that the simple operation is the procedure of *choice* and the combined one of *necessity or selection (opération d'exception)* is probably true. In any event, it is better to do an iridectomy in rigid irides, or those that are not quickly affected by mydriatics; in unripe cataracts; in diabetic cases, and whenever there is any suspicion of posterior synechiæ. To this category might also be added hard cataract occurring in high myopes or in patients having any of the undesirable complications elsewhere mentioned. The iridectomy thus made is one rather of prevention and prudence; the unmutilated iris and the round pupil should be retained if possible.

Preliminary Iridectomy.

It is a question as yet unsettled whether an iridectomy done a few days or a few weeks prior to the extraction of the lens is or is not on the whole, in the interest of the average patient. Doubtless, it is desirable in certain cases. It was first practised by von Graefe, who found

the double operation to be safer (though less convenient) than the whole extraction in a single sitting. Mooren seems to have been the first, however, to advise the operation in *all cases of cataract that require iridectomy.*

Extraction with Iridotomy.

Verhoeff[73] makes the corneal incision in the usual manner. The iris is then grasped with the forceps as near its root as possible and a small bit of tissue excised with scissors so as to leave a small hole in it (Fig. 602.) The iris will immediately return to the anterior chamber of its own accord. de Wecker's small iris scissors, preferably with blunt-pointed blades (Noyes' scissors will probably serve as well), are then introduced through the corneal incision, gently opened, and one blade passed downward through the hole in the iris until it projects

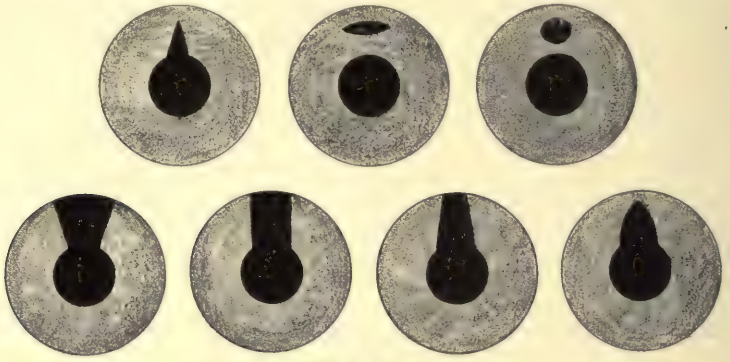


Fig. 601.
Extraction of Senile Cataract.
Some of the Iridectomies and Iridotomies made in Various "Combined" Methods.

below the pupillary margin. The blades are then quickly closed, thus making a clean cut through the iris to the pupil.

Owing to the mydriasis produced by the cocain, the edges of the incision will separate, usually at once, as widely as after an ordinary iridectomy (Fig. 602.) If, however, the iris is pressed against the cornea by the lens, this may not happen until after the lens has been extracted. The lens capsule may now be opened with the cystotome or capsule forceps and the lens expressed in the usual way, or the latter may be extracted in its capsule. In making the toilette of the wound, care should be taken, as after an iridectomy, to free the pillars of the coloboma from the incision. It is probably best to instil atropine im-

[73]Verhoeff. Cataract Extraction with Modified Iridotomy. *Sec. Ophthalm., A. M. A.*, June 5, 1906, p. 481.

mediately after the operation, since this enlarges the coloboma and thus lessens the danger of iris prolapse.

This operation offers the *advantages of both the simple and combined operations without their disadvantages.* The lens is removed with the same ease as in the combined operation, the danger of iris prolapse is minimized, and cortical matter can be expressed with even greater facility than after an iridectomy. Moreover, the modified iridotomy requires no such rough handling of the iris and causes no such pain as iridectomy, while it is superior to the latter in its cosmetic and optical results. The excision of iris tissue is made where it will be most effective in preventing iris prolapse and at the same time do the least damage from an optical standpoint. In the case of iridectomy, a large section of the sphincter muscle is always removed so that the reaction of the pupil to light is necessarily much impaired, whereas in this operation the sphincter muscle is simply incised and the pupillary reactions less interfered with. For this reason, as well as on account

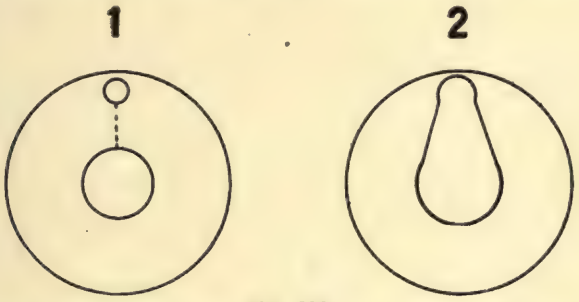


Fig. 602.

Verhoeff's Modified Iridotomy as Compared with the Usual Iridectomy.

of the narrow coloboma finally obtained, the dazzling on exposure to bright light often complained of after iridectomy is, after this method, notably absent. The optical results are, in fact, practically as good as after the simple extraction or the Chandler button-hole operation.

Chandler,[74] to prevent prolapse of the iris, makes a small *peripheral button-hole opening* in that membrane after the delivery of the cataract. At first he simply perforated the iris with his knife, but he now removes a piece of tissue 1 mm. in diameter, making the round opening as near the root of the iris as possible. The object of this small, circular opening is that it not only allows drainage of the intraocular fluids but the cortical matter that collects above and under the iris can be pressed through the opening. Moreover, in washing out the anterior

[74]**Chandler. Report of 312 Cases of Cataract Extraction with a Small Peripheral Button-Hole in the Iris.** ***Archives of Ophthalm.*****, Vol. XXXIII, No. 1, 1904, p. 1. Chandler's first paper appeared in the** ***Boston Med. and Surg. Jour.*****, Oct., 1890.**

chamber the fluid flows backwards through the opening and carries with it all cortical debris. In performing the operation he tries to make his cut exactly at the scleral-corneal junction. After the lens has been delivered, he allows the iris to prolapse for a few moments, knowing that he can remove cortical matter through the opening in it. As a result of this method he has had only three cases of vitreous loss in 312 extractions. Among these there were also four cases of prolapsed iris but two of them were the result of direct violence. In two others it occurred on the second day; the opening having been made too far forwards. Chandler uses forceps with the teeth at the tip and scissors whose blades are very thin; otherwise the opening is made too large and farther down than it should be. The opening is made after the expression of the lens, as it seems that the small amount of aqueous under the iris acts as a buffer and facilitates its extraction.

Peripheral Iritomy as a Safeguard Against Prolapse of the Iris.

Bajardi[75] (as Chandler formerly did) perforates with the point of the cataract knife the periphery of the iris immediately after the corneal puncture, which he makes at the limbus. The point of the knife transfixes the iris and cuts its way through about one-fifth of the circumference of the iridic circle. The knife point is then withdrawn sufficiently to clear the iris, the counter-puncture is made in the usual way and the section is completed. The capsule is then incised with the cystotome (if it has not already been done by the knife) and the lens is delivered, if possible, through the button-hole opening in the iris. The iridic wound sometimes does and sometimes does not entirely heal, but in any event it affords an opening through which the aqueous, as well as lenticular debris may escape. Bajardi pictures many cases operated upon by him and feels much satisfied with the result of the operation.

Dean W. Myers, of Ann Arbor, Mich., has also made use of this procedure, first described by Schweigger (see his account of the downward corneal section). [Central Vision in Aphakic Eyes and a New Method for preventing Prolapse of the Iris. *Homeopathic Eye, Ear and Throat Jour.*, Feb., 1910.] He says:—"There are many cases in which a marked tendency to prolapse of the iris occurs at once following removal of the lens and many authors recommend in all such cases an immediate iridectomy. To overcome this tendency and avoid iridectomy, I have conceived the idea of an iridodialysis at a point in the attachment of the iris corresponding to the center of the primary incision. This I produce by simply passing the ordinary cataract knife directly through the attachment of the iris, thus making a small open-

[75]Bajardi. *Un Metodo per prevenire la Procidenza dell'iride Nell'estrazione Semplice della Cataratta.* Turin, 1894.

ing through which the fluids of the eye may escape directly into the corneo-scleral incision without carrying the iris with them. This permits the iris to float in the anterior chamber until the incision is closed."

"So far it has served us admirably in our work; not a case upon which it has been performed having had the slightest prolapse. In the majority of cases this small opening will close in a few days; but in those cases in which a permanent iridodialysis remains the defect is covered by the corneal scar and overhanging upper lid, giving the patients no trouble from a visual standpoint and being hidden from the observer's eyes by the same means."

INCISIONS INTO AND REMOVAL OF THE ANTERIOR CAPSULE.

Cystotomy.

The methods of opening the capsule are extremely numerous. From the earliest times surgeons have endeavored to *incise the anterior capsule in such a manner as not to leave tags of capsule or flaps* that would be likely to engage in the wound or to remain in the pupillary area and so interfere with vision. To prevent a secondary cataract of this character is the principal object of the great variety of cuts in the anterior capsule and other procedures upon that membrane preceding the extraction of the lens. The fact is, of course, that no ingenuity in making an *anterior* capsular incision will prevent thickening of the *posterior* capsule. It is, unfortunately, often alterations in and deposits on the posterior capsule that make it necessary to do secondary operations.

There is another important purpose in a properly made capsular incision, apart from permitting an easy escape of the lens, and that is the prevention of *iridocyclitis* and *secondary glaucoma* from the retention of capsular tags. These remnants sometimes include lenticular matter and both acting together block the iridic angle. Treacher Collins[76] has discussed this matter fully and gives it as his opinion that many cases of failure of cataract extraction are due to this cause.

The incarceration of a portion of the capsule in the extraction wound is always a dangerous condition. Not only does it delay healing (because the small tag acts as a foreign body), but the hernia of the capsule allows the entrance of septic organisms and acts as a drag upon the ciliary body.

One of the advantages of simple extraction is that it is more difficult for the capsular incarceration to occur if there has been no iridectomy. Moreover, should such an accident happen at the time of the

[76]Collins. *Researches into the Anatomy and Pathology of the Eye.*

operation it is much easier to reduce the piece of capsule than after a combined extraction.

These considerations make it highly desirable that, as Swanzy[77] recommends, the point of the iris forceps should be passed, as a routine measure, between the lips of the sclero-corneal wound and all hernial matter drawn out before the cataract dressing is applied.

Although there are numerous forms of capsulotomy, yet they may be divided into four classes; first, that made by some form of cystotome through the corneal opening; second, that made by the cataract knife during the incision for extraction; third, the preliminary cystotomy; and, fourth, removal of a piece of the capcule by means of specially contrived forceps. These methods will now be considered in their order.

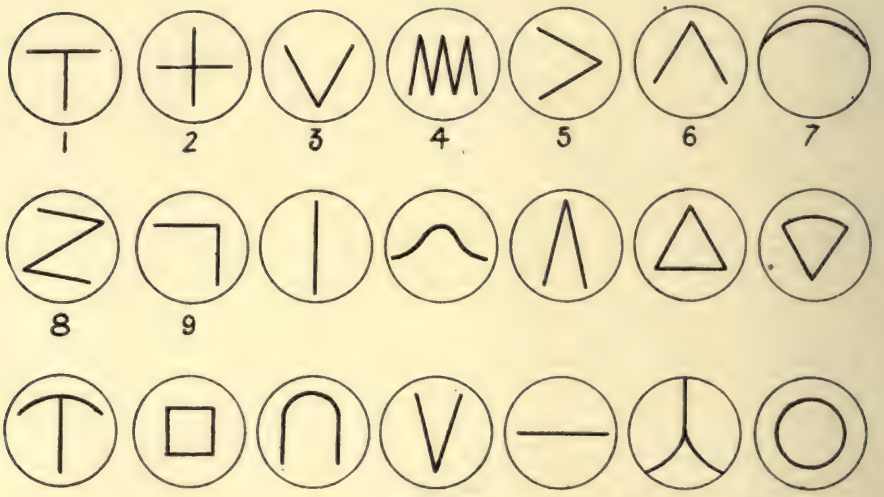


Fig. 603.

Forms of Capsulotomy. The Circle Represents the Dilated Pupil. (After Beard). Those incisions that make angles whose bases are toward the corneal incision are bad because their flaps and tags get into the wound, cause iris prolapse and delay healing, 1, Von Graefe; 2, Von Graefe (crucial); 3, Von Arlt; 4, Von Arlt; 5, Weber; 6, de Wecker; 7, Knapp; 8, Czermak; 9, Agnew.

Cystotomy is by far the commonest method and presents the most numerous variations. As already stated, too much attention has probably been given to the necessity of some *particular form* of this procedure. As a rule, the anterior capsule, when incised, rolls upon itself so that its margins are carried away from the pupillary space. If this be true it matters little what variety of incision is made, provided it is a *clean-cut one,* and is *large enough.* Some surgeons, however, insist

[77]Swanzy. *Trans. Ophthalm. Soc. U. K.*, Vol. XIII, p. 178.

upon making the most elaborate, and it seems to me needlessly complex, figures upon the anterior surface of the lens.

Although it has been highly recommended by experienced operators to make a single incision following, more or less, the outline of the upper part of the lens, so as to admit of easy extraction of the cataract, yet the anterior capsule is more likely, in this case, to come in contact with the posterior, to include some lens matter between the two layers, and thus favor the formation of a dense secondary cataract. In spite of this objection there are experienced advocates of it. Knapp,[78] for example, prefers *peripheric* splitting (as he terms it), as opposed to *vertical* splitting. He thinks that the latter is unfavorable for the exit of the lens, while the former, parallel with the corneal section, offers it the easiest way of escape. He then refers to the capsulotomy of Graefe, who opened the capsule horizontally in its upper part with a cystotome which he then turned and tore the capsule from below upwards to meet the horizontal incision. In this way he made a broad T-shaped opening, which, however, was not always large enough and was abandoned owing to the objection of placing difficulties in the way of the removal of the lens.[79]

A long incision following the vertical meridian is perhaps better than the peripheral cut since, after it, the margins of the wound usually fold up and roll away from the pupillary area.

Making such incisions as to cut out a circle, a triangle or a parallelogram from the anterior capsule is attended by some difficulties. First of all, unless the cystotome point be very sharp and the incision made very exact, the operator fails to remove the piece entire and the result is a separate piece of capsule held in place by a tag that may engage in the wound of operation. As previously mentioned, however, a triangle with the apex pointed downwards and the base curved to correspond with the lens margin, gives, on the whole, the best results.

The upper peripheral capsulotomy was first introduced by Gayet, who made it principally as a part of the combined method. He incised the capsule at the equator of the lens, after tilting the latter forward by pressure below the middle of the cornea.

Quioc[80] divided the capsule at its periphery along the whole length of the corneal wound.

Notwithstanding the stated objections to it, the method of Knapp, owing to the large experience and value of the opinion of the writer on this subject, is detailed here.

---

[78]Knapp. *System of Diseases of the Eye.* Norris and Oliver, Vol. III, p. 798.

[79]Knapp. The Lens Capsule in the Operation of Cataract. *Am. Jour. of Ophth.*, Sept., 1905, p. 262.

[80]Quioc. Thèse de Paris, 1879.

The operator introduces the cystotome into the anterior chamber with the knee forward, from the temporal side, near the conjunctival flap, which latter he is careful not to drag into the eye. He then advances the instrument so that the tip goes beneath the upper part of the iris, turns it and with the tooth makes the incision into the upper part of the capsule parallel with the corneal section, about 6 to 7 mm. in extent. As soon as the capsule is opened the lens makes a visible motion. The cystotome is then withdrawn with the knee forward so that the point does not engage the iris. Knapp claims several advantages for this form of capsulotomy in that there are no shreds to unite with the lacerated pupillary margin and consequently there are no posterior synechiæ. The lens also escapes easily and there are no tags of capsule to engage in the wound, although if an iridectomy has been made there may be adhesions between the capsular and corneal incisions.

Although cortical remains become enclosed by free union of the two capsules, irritation of the iris is avoided and the soft matter, to some extent, becomes absorbed. As mentioned before, the drawback to this method is the frequent necessity for an after operation.

Barck[81] has abandoned Knapp's peripheric method and gradually developed the following: The first incision is of a crescentic shape, commencing laterally from the lower end of the vertical meridian; the second one, commencing just as far mesially from this, meets the first somewhat above the center of the capsule. (See the figure). It is very important that the two incisions really intersect. If correctly carried out, the lower triangular flap as a rule falls downward, and the upper portion retracting, leaves a clear, central pupillary area.

Preliminary Capsulotomy.

A few operators prefer to open the capsule, by means of a needle or knife-needle, either immediately or several days or weeks *before completing the operation of extraction.* Herbert[82] says that this is the routine practice adopted by a number of East Indian surgeons. Haab has employed this method in the cataract of childhod and believes that useful information can then be obtained as to the condition of the cataract itself. He believes that it is also possible to make a better and more definite capsular opening, since the operator can take his time and the field of operation is not clouded by the presence of blood or any other discharge. Moreover, the pupil can be more widely dilated than after the anterior chamber has been emptied. The needle is inserted at the limbus and with a little care there is no escape of aqueous.

---

[81]Barck. How to Avoid Secondary Operations after Cataract Extraction. *Am. Jour. of Ophthalm.*, Oct., 1903, p. 289.

[82]Herbert. *Cataract Extraction*, p. 238.

I have done a preliminary capsulotomy in a number of cases where I had reason to suspect a thickened and adherent anterior capsule, and have never had occasion to regret the procedure. I believe that this is the only reliable "ripening" operation and if the case be closely watched I do not see what disadvantage can arise after it, especially if the case be selected.

L. Müller does his capsulotomy (in the combined operation) *before the iridectomy* so that the upper part of the capsule may float or curl up behind the iris, thus keeping away from the corneal wound.

Preliminary Rupture of the Capsule Before Making the Corneal Section.

Drake-Brockman (p. c.) writes that a few surgeons of repute in India, especially in Madras, urge the importance of this procedure more or less as a routine practice. He cannot personally see much advantage to be gained by such procedure as a matter of routine, but in the case of Morgagnian cataracts he thinks it is sound practice to do so on the ground that it is less likely to be followed by escape of vitreous which

Fig. 604.
Barcks' Fan-Shaped Capsulctomy.

the sudden release of pressure on the hyaloid membrane will usually entail, if laceration of the capsule is left till after completion of the corneal section. It must be borne in mind that the vitreous itself, in cases of Morgagnian cataract is usually more liquid than normal, rendering vitreous escape more inevitable. The slight inconvenience, if any, of the presence of milky matter in the anterior chamber, he has never found seriously to interfere with the making of the corneal section in an efficient manner. These cases, however, should, in his opinion, be invariably followed by thorough irrigation of the anterior chamber and accurate reposition of the iris.

Homer E. Smith[83] practises this method which he describes as follows: A speculum is introduced and the fixation forceps applied. With a small Knapp's knife-needle a puncture is made through the upper part of the cornea, the blade carried down to the lower margin of the dilated pupil and then brought to its upper border, making an in-

[83]Smith. Cataract Extraction with Preliminary Capsulotomy. *Ophthalmic Record*, Oct., 1906, p. 493.

cision not only through the capsule, but partly into the lens substance itself. A similar cut, but at right angles to this, is then made in the mid-pupillary space and the knife is withdrawn. The speculum and fixation forceps are then removed, the eye flushed with an antiseptic solution and a bandage reapplied.

Smith believes that the capsulotomy furnishes valuable information that may guide the operator in the size of the corneal section he will later make. If the cut in the capsule is practically invisible, then it is known that a large nucleus is present and the usual section of the upper two-fifths of the cornea will be required for the easy exit of the lens. If there occurs an escape of semi-gelatinous lens matter, then a section of one-third will suffice, while if there issues a milky liquid then it is known that the cataract is hypermature and the section may be made with the angular keratome. Therefore, no larger a section is made than is necessary and a minimum of risk during the healing process assured. Twenty-four hours at least should elapse between the capsulotomy and the extraction because there is usually a sufficient loss of aqueous to render the eye soft and a proper corneal section difficult.

Opening the Capsule with the Cataract Knife During the Corneal Incision.

This is the *keratokystitomie* of Gayet,[84] who practised it many years ago. The point of the knife is made to incise the anterior capsule shortly after the puncture at the pupillary edge, carrying it across the anterior surface of the lens and as far as possible before the counter-puncture is made. It is best to make the puncture and counter-puncture in the anterior capsule as low down as possible and for this purpose the knife is directed rather downwards during this part of its course. This causes the incision to be semicircular in shape. Some operators prefer to extend the puncture vertically, but in attempting to perform this part of the operation aqueous is likely to escape and the corneal wound to be irregular.

While this manœuver reduces the number of instruments passed into the anterior chamber during the operation, yet its disadvantages are many. In the first place, the capsular incision is apt to be too small, especially in large, ripe lenses and if the capsule be tough or thickened. Added to these drawbacks is the possibility of pressing the lens backward in the attempt to cut a thick capsule, and of dislocating it afterwards if the transfixion be very deep. I have, however, seen good results in the hands of at least two surgeons, who have extensively used this method of capsulotomy, namely, Sir Anderson Critchett and Trousseau.

---

[84]Gayet. De la Keratokystitomie dans l'Operation de la Cataracte. *Annal. D'Ocul.*, Vol. XCV, 1886, p. 227.

Puncture of the Posterior Capsule.

This procedure is obviously indicated at the time of the extraction *if there be a central opacity in the posterior capsule,* because it renders unnecessary a second operation. However, some surgeons advise it as a routine performance so as to avoid the subsequent opening of the capsule. Both Schweigger and Hasner have advocated this operation, the latter not only to anticipate formation of after-cataract but to raise the cornea through the forward pressure of the vitreous in the adjustment of the wound margins, where the sclera is rigid and the cornea has collapsed. Hasner[85] used a cataract needle and made an extensive vertical incision in the posterior capsule. During this operation the blepharostat should be removed and no pressure exercised upon the eyeball by the dressings until the corneal incision is firmly healed. That there be no loss of vitreous the act should be performed just before the post-operative dressing is to be applied—after cleansing of the wound of incision and of the field of operation.

Webster Fox[86] has been in the habit of *opening the posterior capsule* by means of a gilt, enameled hook. It is of malleable steel that may be bent to any angle. This hook is passed into the anterior chamber and behind the lower pupillary margin of the iris. It is then rotated backwards, hooked into the capsule, drawn to the mouth of the incision, once more rotated and then removed from the chamber. By this means the capsule is torn and the vitreous pressed forward between the rent. It rarely shows at the mouth of the wound, but if it does it is snipped off. Fox has been in the habit of performing this operation in alternating cases for ten years. As a result he finds that those patients upon whom the operation was performed required a secondary needling in only 15 per cent. of the cases; when it was not performed, in about 75 per cent. In the former class, he attributes the necessity for the secondary operation to the vitreous receding from the wound after closing the eyeball and thereby not keeping the capsular lips separated, so that they closed again. He adds that there is less danger of inflammation of the eyeball after immediate capsulotomy than in a subsequent operation.

Other Forms of Anterior Capsulotomy.

Mark Stevenson[87] uses a cystotome with a blunt end so that the iris is not injured when the instrument is pushed under it. It also has a sharp knife-edge that will cut either way. This instrument is passed, with its cutting edge backward, across the anterior chamber and for

---

[85]Hasner. *Prag. Med. Wochenschr.*, 1864.

[86]Fox. Immediate Capsulotomy Following the Removal of Cataract. *Trans. State Med. Soc. of Penn.*, May 17, 1894.

[87]Stevenson. *Loco cit.*

some distance under the distal portion of the iris, usually towards the nasal side. One straight cut is then made across the whole lens, across the pupillary area about 1 mm. from the edge of the iris into the coloboma made by the iridectomy, so that the incision extends as nearly as possible throughout the whole anterior capsule and not merely in its pupillary portion. The cystotome is then again passed under the distal portion of the iris but on the opposite side and a second cut is made passing more nearly to the center of the pupillary space and meeting the first incision at the beginning of the coloboma.

This operator believes that the method is a simple and easy one and that as a result of it there are no strips or tags of capsule that can possibly get into the corneal wound.

A. J. Erwin[88] prefers the following course:

"Having dilated the pupil, I enter the cataract knife in the clear corneal margin at the equator. Advancing on a plane declining ten degrees from the horizontal, I transfix the capsule, then raise the point of the knife and counter-puncture the cornea two or three mm. above the equator, and complete the corneal flap in its clear margin. Unless the capsule be unusually brittle the knife will pass up under it to the pupillary margin, *cutting a smooth central flap about the size of the ordinary pupil*, which will be enlarged by the passage of the lens. This large flap will naturally fall to the lower segment of the capsule, leaving a clear pupil. This operation seems to me to be so safe, so complete, and withal so easily made, that I cannot comprehend why it has not been commonly adopted. Of course, there are cases that require the forceps or cystotome, especially the contracted pupil, requiring an iridectomy, but even in this class a central vertical slit can be made in the same way, which will often be sufficient for the escape of the lens after the completion of the iridectomy. I believe my results have been unusually good."

Capsulotomy in Opaque, Thick and Tough Capsules.

The difficulties in dealing with these abnormal membranes have been referred to several times. It may be added here that especially in Morgagnian cataracts (so often provided with opaque capsules) the capsulotomy must be made with an exceedingly sharp, needle-pointed cystotome. The needle-point should be quickly and firmly entered and some pressure exerted upon the sac while making the incision. Even then one may fail in doing a proper capsulotomy. For this reason, perhaps, it is well to resort to the method of Terson who employs a special capsule forceps (q. v.), in addition to the cystotome, for dealing with these unusual cases.

Herbert[89] advises that one should make the primary cut in a Morgagnian capsule horizontal, and that this opening often has to be enlarged, even at some slight risk of the escape of the imprisoned nucleus.

In this connection one should remember that Knapp advised his

---

[88]Erwin. How Shall We Open the Capsule? *Ophthalmic Record*, August, 1903, p. 363.

[89]Herbert. *Loco cit.*, p. 111.

"peripheric splitting" (q. v.) as especially adapted to the opening of these inelastic capsules.

When the fluid has been absorbed in a Morgagnian cataract so that it consists mostly of the nucleus in a tremulous, shrunken bag, a capsulotomy is an extremely difficult and unsatisfactory operation. Should a capsulotomy (always with a very sharp cystotome) fail it is better to remove, very cautiously, the partially absorbed cataract in its capsule by means of hook or forceps.

When the cataract is not only over-ripe but plainly shows a *circumscribed, central opacity* (sometimes of the *discoid* variety) the method of Terson should be employed; or at least the capsule is best removed by the employment of both forceps and cystotome. Probably this form of cataract had best be removed in its entire capsule, as in the foregoing instance.

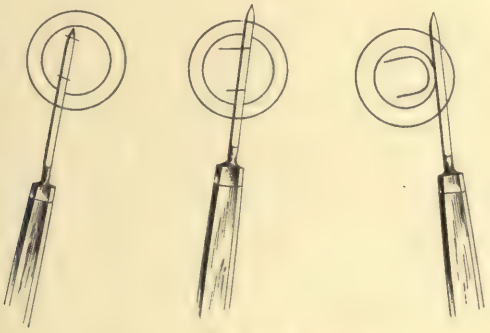


Fig. 605.
The Steps of Erwin's Capsulotomy.

Removal of a Portion of the Anterior Capsule.

This is also a very old procedure, having been in vogue since the days of Daviel, especially when the capsule was found to be opaque.

It was not until 1874 that Förster began to employ this method as a part of the routine extraction. It is now adopted by many experienced surgeons and is a procedure that has many advantages to recommend it. Although practised both in the simple and combined operations it seems better adapted to the latter method because the iridic coloboma offers a larger opportunity for the use of capsular forceps.

There are many forms of forceps and methods employed for this purpose. Probably the best known instruments are those of Couper, Förster, de Wecker, Eugene Smith,[90] Terson, Sattler, Tooke and Lagrange, although many other operators (see Dr. Guilford's chapter)

[90]Eugene Smith. Extraction of Anterior Capsule in Cataract Operations. *Am. Jour. of Ophthalm.*, Nov., 1904, p. 339.

have from time to time invented instruments and presented them to the profession.

It must be remembered in this operation that even after the teeth of the capsule forceps grasp the anterior capsule near its center, the drag upon the membrane generally produces a rupture at or near the equator of the lens, because here the capsule is thinnest.

In performing the operation the patient is asked to look down and the eyeball is fixed below in the vertical meridian. The surgeon should have a clear view of the anterior capsule. The forceps are then introduced (closed) and the blades directed straight downwards. They are passed to the lower border of the pupil, and slowly opened to their fullest extent. The terminals are then pressed very carefully and slightly backward against the anterior surface of the lens and closed. The forceps are then—always gently—pushed downwards. By this latter manœuver the capsule generally ruptures above. With a careful side-to-side movement the instrument, with the torn piece of capsule, is removed from the anterior chamber. If this manœuver has been properly performed the lens will come forward and the subsequent extraction is easy. Failure to sieze the capsule in the first instance may be followed by a second trial. In soft, semi-fluid or swollen cataracts, especially if the capsule be tough, it is not easy to grasp the membrane. In attempting to tear out a piece of capsule in this way *care should be exercised not to use force of any kind or in any direction* lest the suspensory ligament be torn, the lens dislocated or some other injury be done to the ciliary body. If a reasonable attempt to use the capsule forceps fails a cystotome should be substituted, as repeated attempts to perform any step of a cataract operation is likely to demoralize the patient, while the efforts themselves may cause loss of vitreous or produce some other undesirable trauma.

Even when using his forceps, Terson, Sr.,[91] made a small opening with the cystotome in the lower part of the capsule when that membrane was found to be decidedly opaque. He believes that in each and every case the anterior capsule should be studied by the oblique illumination through the well dilated pupil. If there are no markings on the membrane it is to be regarded as suitable for capsulectomy. If, however, there are visible markings the operator is advised to make a preliminary incision, as described, as this facilitates the removal of the capsule with the forceps. He directs, following his method, that the closed forceps be passed, as usual, to the lowest part of the pupillary area and there slowly opened to its widest extent. The teeth will then press into the capsule and the forceps close firmly on the anterior capsule. When the latter is seized the forceps are drawn slowly upwards

[91]Terson. *Annal. D'Ocul.*, Vol. 139, p. 420.

with the customary side-to-side movement. He urges that the operation is one of some delicacy and that the seizing of the capsule should be carefully done, that no roughness should be allowed else the lens matter be dislocated and vitreous lost.

Finally, Birnbacher[92] first outlines a piece of capsule with a special knife before applying the capsule forceps. This rather complicated operation is performed with the purpose of avoiding the danger of leaving loose shreds behind.

In *small and rigid pupils* it is generally desirable to do a wide iridectomy, in which case capsular forceps may be used but they are always contraindicated in rigid irides if the extraction be a simple one.

In any event, *as much of the anterior capsule,* which is generally about 9 mm. in diameter, *as possible should be extracted.* Both de Wecker and Förster believe that the excised portion should measure 6 or 7 mm.

The most recent arguments in favor of the use of capsular forceps are those presented by Treacher Collins,[93] who reports that in a series of 100 cataract extractions with this instrument only 4 per cent required

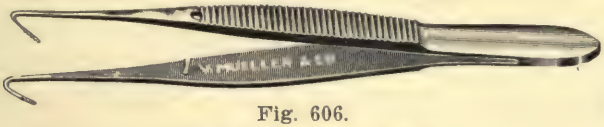


Fig. 606.
Fisher's Capsule Forceps.

needling and 25 per cent. obtained normal vision without secondary capsulotomy.

W. A. Fisher (p. c.) has devised a pair of capsule forceps whose terminals are bent at an angle of about 40 degrees, so that the right-handed operator on the left eye may stand in front of his patient and not be obliged to change his position after the section has been made.

F. Tooke[94] has devised a pair of capsule forceps whose handle is approximately 8 cm. long, tapering to a slender tip, where an extension arm of about 8 mm. is welded at an angle of 120 degrees to each blade. These *tips are curved concavely below and conform to the underlying convex surface of the lens.* The tiny, sharp teeth are directed downwards and inwards and interlock at the distal ends of the tips. This instrument has one or two advantages over other patterns. After inserting the tips into the chamber, pressure may be more evenly distributed over the whole zonular ligament, and consequently minimized

---

[92]Birnbacher. Ein neues Verfahren der Kapsel-Entfernung bei Star-Operationen. *Centralbl. f. prakt. Augenheilk.*, 1894, p. 70.

[93]Collins. *British Medical Jour.*, Vol. II, 1905, p. 433.

[94]Tooke. Capsule Forceps in Cataract Extraction. *Montreal Med. Jour.*, Vol. XXXVIII, May, 1909, p. 318; see, also, *Ophthalmology*, Oct., 1909.

at any one particular point where it must of necessity be exerted in other patterns where one point only is directed, as well as in the case where the cystotome is employed. The blades or tips of the forceps being curved concavely downwards an entanglement of the iris fibers need not occur.

Extraction After Instrumental Rotation of the Lens.

Geo. H. Powers writes me as follows:

"My discovery began with the accident of trying to incise a lens capsule with a cystotome which proved to be dull, and which, instead of cutting, rotated the lens on its horizontal diameter, thus plainly rupturing the suspensory ligament. As I almost always operate without iridectomy, I have hesitated to pursue the matter, but have proceeded to incise the capsule in the usual way before extraction; but I have a good many times done this *rotation of the lens*, and have never failed to accomplish it without any force or appearance of possible damage to the eye. In the last case on which I operated a week ago I had made an iridectomy four years ago, and concluded to try to extract the lens *in its capsule*. With the eye well cocainized after an incision, including nearly one-half the periphery of the cornea, I passed the cystotome to as low a point as the iris would allow, plunged it into the lens substance (a little more deeply only than if intended to incise the capsule alone), and then with the gentlest possible motion rotated the whole

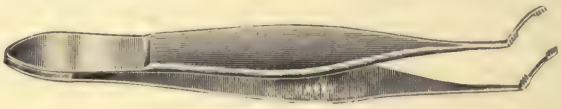


Fig. 607.
Tooke's Capsule Forceps.

lens as a wheel. Very gentle pressure at the bottom of the cornea expressed the lens which, in formalin solution, shows very plainly the capsule unbroken.

"With proper cocainization it would seem that no vitreous need be lost during or after this operation; certainly none was lost this time. The traumatism to the ciliary body is certainly less than in Major Smith's method, and the expression of the lens is easier than in the usual operation."

Delivery of the Lens.

Bradburne (p. c.) believes that *rotating the lens a trifle to one side with the point of the cystotome* just before it emerges from the corneal opening, will often bring about the deliverance of a cataract which at first seems obstinate to deliver. No doubt this end is attained by the rupture of the weaker zonula fibers.

Drake-Brockman (p. c.) says that in recalcitrant patients and where palpebral spasm is at all present, he never proceeds to express the lens without at first removing the speculum from the eye. The presence of a speculum in the eye in such cases is almost certain to be followed by escape of vitreous, for it must be remembered that any pressure exerted by the eyelids, while a speculum is propping them open, must tend to force the contents of the eyeball along the line of least resistance, which is, of course, the corneal incision.

Under such circumstances, he usually removes the speculum altogether as above mentioned, and introduces a medium-sized Desmarres' retractor under the upper eyelid. He then draws the latter upwards and well off the globe to release all pressure, and by gentle massage and judiciously exercised pressure with the pad of thumb or forefinger of the other hand, applied to the lower portion of the eyeball over the lower eyelid, and, as it were, through it, one is able most effectually and neatly not only to express the lens through the corneal incision, but to follow it up with nearly all the torn capsular matter attached thereto. This method has, besides, the advantage that no instruments are brought into direct contact with the cornea or conjunctival sac for the purpose of expression or delivery of the lens, which must lessen the chance of septic infection and injury to the corneal epithelium. He also finds that this method of removal of the lens is more efficient in cases when it is decided to extract a cataract without a preliminary iridectomy, where at times a little more pressure is necessary to overcome any resistance of an intact and possibly rigid iris. This pressure is by this method more evenly distributed over the globe and so is less liable to cause rupture of the hyaloid membrane with its subsequent extrusion of the vitreous, a complication which, he thinks, most ophthalmic surgeons are agreed should be avoided at all costs.

Rollet[95] uses a miniature hook with which he fishes out the lens from the anterior chamber. He says that the crystalline must not be harpooned or spitted, but the sharp point of the (fish) hook entered so that traction and rotation may be extended upon it after the usual iridectomy and capsulotomy. He uses it very successfully, also, in luxations of the lens and has, in fact, had 17 cases of this accident which he treated by the use of the instrument. He believes that in all forms of senile cataract it ought to take the place of the usual means of assisting the birth of the lens.

Intraocular Irrigation During Cataract Extraction.

The revival of intraocular irrigation for the purpose of freeing the anterior chamber of cortical remains and capsular tags is mostly due to McKeown, whose monograph *(Treatise on "Unripe" Cataract,* 1898) is well worth perusal. He advised it especially in immature cataract or in lenses presenting sufficient opacities to materially interfere with vision. Before expression of the lens he injected fluid *beneath the capsule* by means of a hypodermic-like needle. McKeown has had excellent results following this procedure and only two cases of iridocyclitis and one suppuration in 146 extractions.

[95]Rollet. De l'extraction du cristallin au crochet-hameçon. *L'Ophtalm. Provinciale,* V, Oct., 1908, p. 149.

Where intraocular lavage is employed as a part of the extraction it is all the more incumbent on the surgeon to insist upon an aseptic condition of the field of operation—especially of the lid margins. In the manipulation of the douche there is always a chance that microbes and toxins, if present, may float or be sucked into the anterior chamber, to work future mischief. Digital massage of the palpebral tissues upon the eyeball, combined or not with stripping the lid margins with a strabismus hook several times during the day or two preceding the extraction, is a useful adjunct to the usual preoperative technique. These manœuvres force out the unclean deposits in the Meibomian and conjunctival follicles and, I believe, render subsequent attacks of iritis less likely.

Herbert *(loco cit.,* p. 247) believes that, all things considered, irrigation has a decided value in removing cortex more completely, easily and quickly than would have been otherwise possible; enabling one to extract unripe cataracts that are often difficult to manage. He finds that the wound margins are left cleaner than in operations without irrigation and that this undoubtedly helps to bring about more rapid union of the wound.

Instead of the cystotome I have used and *think highly of the capsule forceps* (q. v.) in conjunction with strictly clean intraocular lavage. I believe that in the hands of the average or inexperienced operator, better results in the *treatment of unripe lenses* will follow from the employment of these two agencies than after the Smith-Indian operation.

Lagrange and Aubaret[96] have invented an apparently useful instrument that combines the principle of *simultaneous injection with aspiration.* This syringe is made by Creuzan, of Bordeaux, and its construction may be understood by consulting Fig. 608. The inventors believe that the most careful asepsis and antisepsis of all the parts involved in the operation should be kept in mind. They also believe that the fluid employed should closely resemble the aqueous humor, should be of the same temperature as the eye and should be entirely free of the least suspicion of foreign matter. They have chosen as the irrigating fluid a mixture of 1,000 grammes of water, 6.890 grammes of chloride of sodium, 0.113 of calcium chloride and 0.221 of potassium sulphate. Used according to directions these surgeons have never seen a single case of that corneal opacity which is not infrequently observed after intraocular lavage, nor have they found any difficulty in removing most of the lenticular mass, and this without producing any immediate or subsequent irritation of the eye itself. The solution is placed in 100-gramme bottles, carefully cleansed and sterilized. Immediately before the operation the bottle with its contents is heated in

[96] Lagrange and Aubaret. De Lavage Intra-Oculaire dans L'Opération de la Cataracte. *Archives d'Ophtalm.*, Feb., 1905, p. 73.

a water bath of 37 degrees C. and kept at that temperature until the moment of injecting it.

Paul Roethlisberger[97] has given a complete history of this procedure, together with an account of all the appliances used, as a part of cataract extraction, in washing out the anterior chamber, to the date of his essay.

From what I know of the *intraocular irrigator* of Allen Greenwood,[98] I believe it to be a practical and useful modification of the earlier instruments. This irrigator was devised with the object of combining lightness and ease of manipulation with the assurance that the return flow of irrigating solution from the anterior chamber should be as free as possible. To insure lightness the metal tube through which the rubber feed tube passes is made very thin, light and only about the size of an ordinary round pencil. About half an inch from one end a crescent-shaped segment is removed to allow the finger-tip to completely compress the rubber tube at that point and thus control

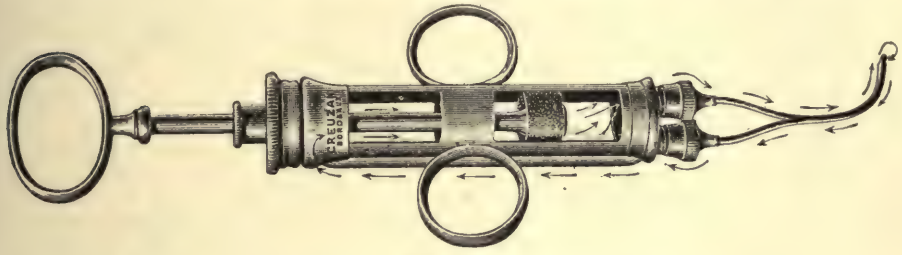


Fig. 608.
Intraocular Irrigator of Lagrange and Aubaret.

the flow. The free return of fluid from the anterior chamber is insured by the little metal rod which can be seen in the illustration extending across the concavity of the tip like the string of a bow. When the tip is inserted into the anterior chamber, or even into the lower part of the posterior chamber, the rod serves to elevate the corneal flap and thus permit a free return of the debris-laden fluid. After the expulsion of a lens, Greenwood never makes pressure on the cornea to assist in the removal of cortical debris but irrigates for the removal of such debris in all his cataract cases.

The whole apparatus may be boiled and thus thoroughly sterilized. When sterilized and filled with warm, sterile (normal) salt solution just prior to being used, the metal tube and tip may be dropped into the reservoir until the moment for irrigation arrives.

---

[97]Roethlisberger. *Ausspühlungen der vordern Augenkammer bei der Starextraction.* Inaug. Diss., Basel, 1893.

[98]Greenwood. An Intraocular Irrigator. *Ophthalmic Record*, June, 1906, p. 263.

The following manœuver, as described by Skeel,[99] seems worth recording. When the cataract knife is finally withdrawn, a grooved and bent spatula is introduced and turned transversely in the wound and a stream of warm, sterile, normal-salt-solution from a siphon irrigator directed upon the spatula at the point where it enters the wound. The fluid will follow the curve of the spatula, creating a brisk current in the anterior chamber and will flow out again bearing with it the lens matter. If the lens is in a flocculent condition, this method will remove all of it, leaving a clear, black pupil. If the lens-matter is gelatinous, or retains its structure, it will be necessary to introduce the spatula and disintegrate what remains, repeating the manœuver until it is all removed, using greater care as the spatula approaches the

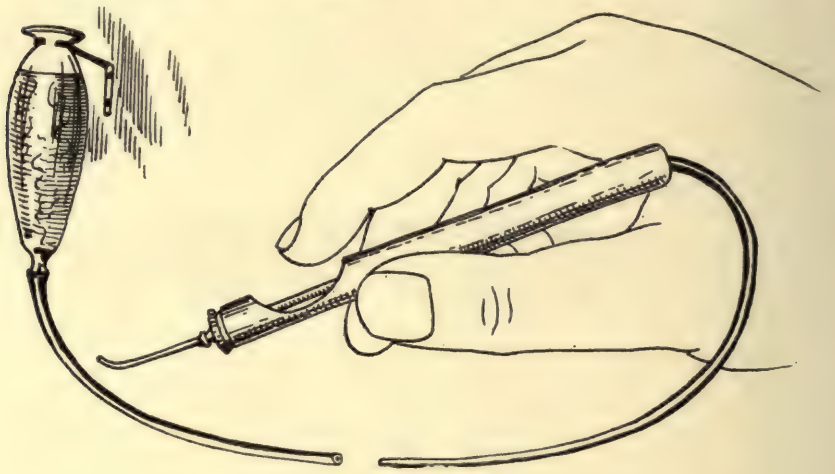


Fig. 609.
Greenwood's Intraocular Irrigator.

posterior capsule. It is rarely the case that a second operation is required when this method is employed.

When Shall Discission of the Posterior Capsule Be Done?

Many surgeons, Webster Fox among the number, favor the *routine employment of splitting the posterior capsule,* i. e., whether there is opacity of the latter or not. In other words, it is to be mostly regarded as a prophylactic measure. The only aspect of this form of discission that I propose to discuss here is the interval that may properly elapse between the extraction and the secondary capsulotomy. Herbert, in India, generally did the needling at the end of ten or twelve days; de Lapersonne, twelve to fifteen days; Mayweg, on the tenth day; Haab, in 2 or 3 weeks and Knapp, at the end of six weeks. But why not do

[99]Skeel. Notes on Cataract Extraction. *Am. Medicine*, Nov., 1907, p. 650.

it—other things being favorable—just as soon as the incision is sufficiently closed? There is little or no reaction from an early discission with a sharp knife-needle or a thin Graefe knife. Is it not better to accomplish, as a part of the major operation, the important end of insuring the best vision possible, instead of inflicting upon the patient and oneself all the disappointment, worry and anxiety attendant upon a slow decrease in vision and the ordeal of a separate, second operation? Even in the most favorable cases a discission of the capsular remnant seems to be justified in at least 60 per cent. of all cases of extraction, yet when proposed for after-cataract it always appears to the patient to be an unforeseen contingency—one that the oculist should have provided for but did not.

Conjunctival Suture After Cataract Extraction.

E. E. Maddox (p. c.) believes that this procedure is of special value on those occasions when vitreous is lost. Two or three sutures put in carefully are also of great value in the promotion of healing, and in the prevention of septic infection. The sutures draw the cut sur-

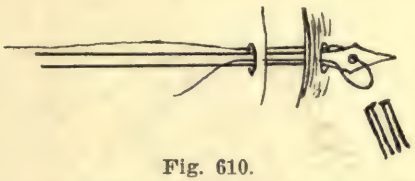


Fig. 610.
Maddox's Conjunctival Suture in Cataract Extraction.

faces of the cornea and the sclera into apposition sufficiently close to enable them to unite by first intention; at the same time squeezing out any vitreous that may be interposed between them. Unnecessary traction is of course to be avoided, since it would make the flap override the sclera too much.

He had a fine circular hole drilled through the head of a discission needle and finds it very useful for the purpose of *suturing the conjunctiva.* After transfixing the conjunctival flap, and then the cut edge of the scleral conjunctiva, with the aid of a fine straight iris forceps he next withdraws the needle a little. This slight withdrawal causes the suture beyond the conjunctiva to form a little bend quite easy to grasp with the iris forceps. This is firmly held while the needle is withdrawn, leaving the suture ready for tying. The needle should be slightly curved on the flat.

After an ordinary extraction the conjunctival flap adheres so soon that a suture is unnecessary, but in those rare cases which are performed under chloroform, it is of great advantage, as affording greater security in the event of vomiting taking place. Patients, also, who are

addicted to sneezing and coughing, are always safer for a conjunctival suture.

Suturing the Cornea.

This method is intended to prevent extrusion of any portion of the ocular interior after the section has been made. H. W. Williams of Boston, was the first *(Roy. Lond. Oph. Hosp. Reports,* Vol. VI, pt. 1, 1867, and *Archives of Oph.,* Vol. I, 1869, p. 102) to propose a corneal suture after extraction of the lens. Since then Chisholm *(Richmond Med. Jour.,* Vol. 4, 1867, p. 307), Suarez de Mendoza (Suture de la cornée, *Soc. fr. d'ophtal.,* Vol. VII, 1889, p. 30), C. H. Williams, Vacher, Kalt (Suture de la cornée, *Arch. d'Ophtal.,* Vol. XIV, 1894, p. 639), in addition to other operators, have improved the original method so that it is of value in certain cases. Kalt thus describes his operation, which is illustrated in the text: After cocainization and dis-

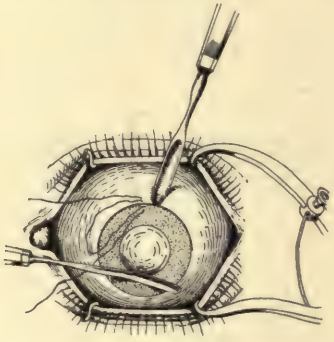


Fig. 611.
Extraction of Senile Cataract.
The Employment of the Corneal Suture (Kalt).

infection he passes through the cornea a needle (which should be very small, fine and sharp) armed with the finest linen suture. It is of great importance that the *point of the needle should not reach the anterior chamber or pierce the whole thickness of the cornea.* It should pass into and out of the *substantia propria* on one side of the proposed wound, then obliquely through the opposite border of the limbus and, in the same way, through the scleral tissue, just as in making a muscular advancement. The loop is then drawn to one side so as to clear the incisional line. When the loops of thread are placed (as shown in the figure) the corneal section is completed, care being taken not to cut the threads, and to place the incision exactly so that it will be midway between the entrance and exit of the corneal and scleral stitches. The operation is then completed in the usual fashion and the threads tied in a single knot.

W. H. Bates (Suture of the Cornea After Removal of the Lens, *Archives of Ophthal.*, Vol. 27, 1898, p. 181) has furnished a complete account of the work done by previous observers, together with a comparison of lens extraction from the rabbit's eye. From this paper I have taken the accompanying illustrations. Bates concludes that the use of sutures to close the wound in the operation for the removal of the lens in man is a valuable improvement in the technique of cataract extraction.

Fig. 612.
Diagram of the Corneal Suture of H. W. Williams.

The chief objection to the use of conjunctival and corneal sutures is, as Melville Black[100] has pointed out, that something like a second operation must be endured by the patient and carried out by the surgeon. For their removal the eye must be prepared for operation in the usual way, anesthetized, a speculum introduced and instruments employed upon the globe.

Czermak's Sub-Conjunctival Extraction.

This procedure is described by the author.[101] He used a large knife (see Fig. 616) with which he entered the anterior chamber at

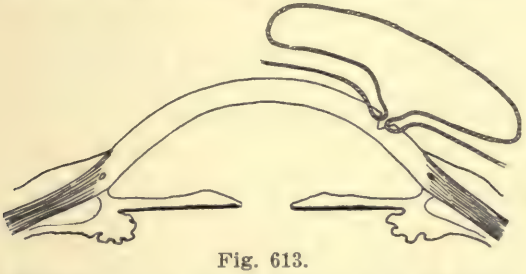


Fig. 613.
Diagram of the Corneal Suture of de Mendoza.

the temporal end of the horizontal corneal meridian, the puncture being made through the conjunctiva well beyond the limbus. It is then passed to the center of the pupil and the point, acting as a cystotome, opens the lens capsule. It is then entirely withdrawn. The operator now makes

[100]Black. Review in the *Ophthalmic Record*, Feb., 1905, p. 75.
[101]Czermak. Ueber subkonjunctivale Extraktion. *Bericht der Ophthalmolog. Gesellsch.*, 1903, p. 115. Also, Subkonjunctivale Extraktion mit Bindehauttasche. *Klin. Monatsbl. f. Augenheilk.*, Aug., 1903.

another incision through the conjunctiva downwards about 15 mm., and undermines it a little beyond the inner end of the horizontal corneal meridian. Care should be exercised not to cut through the conjunctival flap, which is now raised by means of forceps in the hands of the assistant. The surgeon, at this stage of the operation, introduces into the anterior chamber the posterior blade of a pair of blunt-pointed and curved scissors. He then divides the cornea around the

Fig. 614.
Diagram of the Corneal Suture of Kalt.

margin subconjunctivally, as far as the first incision. The operator now expels the lens by making pressure over the upper part of the cornea, at the same time depressing the posterior lip of the wound. If the original opening in the anterior capsule, made with the point of the cataract knife, be insufficient to permit of the escape of the lens, a cystotome is brought into play. The cataract now glides into the conjuctival pouch from which it is easily removed; and the wound in the con-

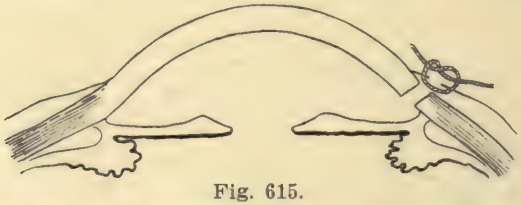


Fig. 615.
Diagram of the Corneal Suture of C. H. Williams.

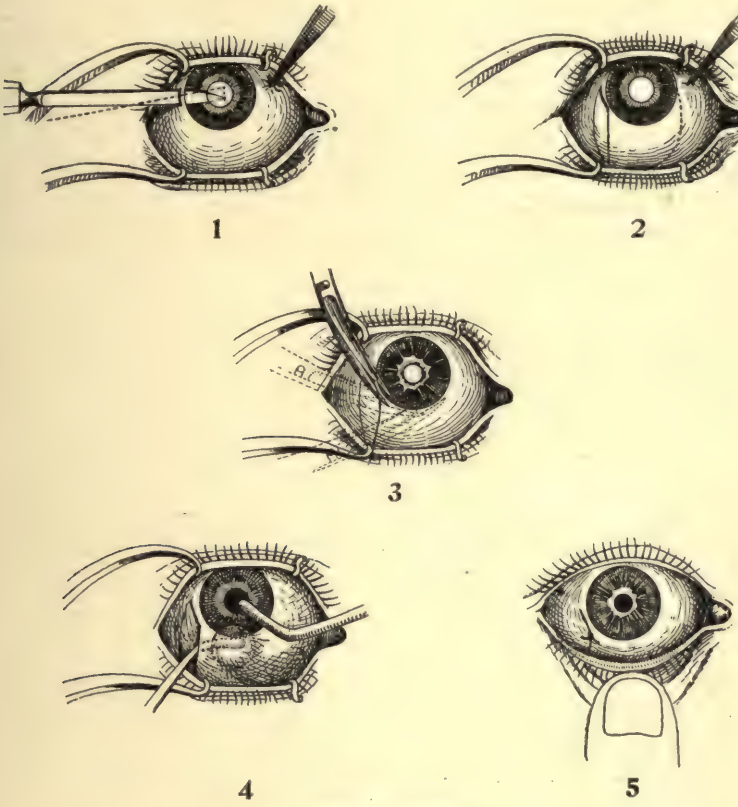
junctiva is closed by a couple of sutures. Figs. 617 to 620 will further serve to elucidate the foregoing description of this operation.

At the close of the operation eserin solution is instilled and a protective bandage applied. Czermak advises that an hour before the operation a dose of trional or veronal be given and that the patient be kept as quiet as possible after the operation.

Subconjunctival Extraction of Cataract—Other Methods.

Dimmer has modified the Czermak operation and somewhat simplified it. He first tattoos with India ink the operative field about

the limbus and conjunctiva, as represented in the accompanying cut. The conjunctiva is incised down and out for 8 mm., and the same distance parallel to the sclero-corneal junction. It is then undermined over the whole area outlined by the tattooing. The subsequent corneal incision is divided into three stages. The middle third is first opened by means of a keratome and this incision is extended with scissors on either side, as in the Czermak operation.



Figs. 616-620.

The various steps of the Czermak sub-conjunctival operation. (After Czermak).

1. Puncture with the Large Graefe Knife.
2. Conjunctival, Inner Incision Along the Dotted Line.
3. Incision of the Cornea with Scissors.
4. Escape of the Lens Into the Conjunctival Pouch.
5. Final Result. Conjunctival Suture.

In addition Dimmer now (Eine subkonjunktivale Methode der Starextraktion, *Bericht der Ophthalm. Gesell.*, 1907, p. 218) places a suture in the conjunctival flap by which he raises it, with the attached

cornea, opens the capsule and expels the cataractous mass. The thread is then tied, to close the cut in the conjunctiva.

Bajardi[102] also does extraction of cataract by a subconjunctival method that much resembles that of Czermak, except that the incision is made entirely with a Graefe knife. He makes his sclero-corneal incision upwards to include from one-third to two-fifths of the circumference, the puncture and counter-puncture being ½ mm. within the conjunctival circle. The conjunctival flap above is cut from 12 to 15 mm. broad. He then makes an iridectomy, opens the capsule with a cystotome or with a cystotome forceps; then, with a Daviel spoon beneath the conjunctival flap (applied at the edge of the wound) he makes gentle pressure backwards and expresses the lens by means of another spoon bearing upon the ciliary region below. The subsequent acts are the same as in the ordinary operation.

Cluckie[103] describes an operation which closely resembles that of Czermak. The extraction proceeds as usual to a point where there is

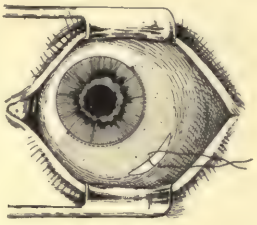


Fig. 621.
Dimmer's Sub-Conjunctival Method of Senile Cataract Extraction.

left a connecting flap or bridge between the cornea and the conjunctiva, about 4 mm. broad. Instead of completing the corneal section in the usual fashion, the Graefe knife is carried farther up under the bulbar conjunctiva for from 10 to 12 mm. and is then withdrawn without cutting through the conjunctiva. We thus have a corneo-conjunctival bridge, which may be broad or narrow, but the broader and longer the conjunctival attachment to the cornea the greater the chances of success and speedy recovery.

The object in having a large corneo-conjunctival band is to allow of sufficient bulging or gaping of the wound to take place, so that when pressure is applied by a Daviel's spoon on the lower part of the cornea the wound opens sufficiently to allow of the exit of the lens and to close immediately pressure is withdrwan. If the surgeon desires to perform iridectomy at this stage it is best done upwards and inwards; the cap-

[102]Bajardi. Sulla estrazione sottocongiuntivale della cataratta. *Bollett. della R. Acad. Med. di Genova*, Vol. XXV, N. 1-2, 1910.

[103]Cluckie. A Corneo-Conjunctival Bridge; A New Method of Cataract Extraction. *The Lancet*, Oct., 1909.

sule of the lens may be ruptured either before or after the iridectomy from the temporal side. By these means the operator will feel that he has complete command of the eye, no matter how nervous or restless his patient may be.

George Crainiciann, as the result of animal experimentation, suggests (p. c.) extraction of the cataract *through a retrociliary incision* and pictures the instruments (see illustration) both of which, forceps-spoon and toothed-forceps he has used for the purpose. He first communicated this idea to the *Roumania Spitaluk,* 1897, p. 44. Of course, it remains to demonstrate its value on the human eye.

After-Treatment of Cataract Extraction.

E. E. Maddox (p. c.) generally prefers a *guarded open* treatment, but when dressings have to be applied resorts to the expedient of laying

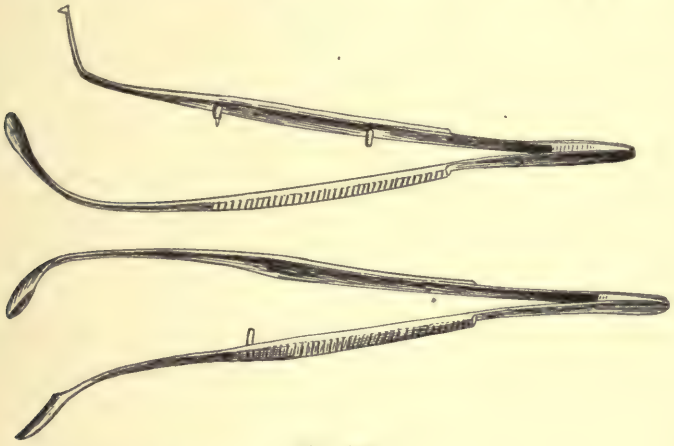


Fig. 622.

Forceps Spoon and Toothed Forceps for use in Crainiciann's Retrociliary Cataract Extraction.

a small salt-spoonful of *powdered boric acid* in the hollow between the closed eyelids and the nose. A circle of wet lint is laid upon the powder and this again covered with gutta percha tissue, with such upper dressing as the case requires. The flow of tears keeps the eye bathed in a saturated solution of boric acid, which militates against septic infection. This procedure, he adds, has nothing in common with that of Haab, who obliterates the canaliculi with iodoform powder, to mechanically prevent exit of microbes from the sac when there is a suspicion of dacryocystitis. There is nothing to contra-indicate the employment of both procedures should they appear desirable; the iodoform before closing the eye, and the boric powder after it.

Wicherkiewicz[104] prefers the "open" method of treating operative wounds of this character. He uses a simple protective shade, made of paper, which is kept in place by adhesive material applied to its borders. This dressing may be removed and renewed as often as is necessary to make applications to the eye itself.

SOME OF THE ACCIDENTS AND COMPLICATIONS OF SENILE CATARACT EXTRACTION AND THEIR TREATMENT.

Although Dr. Ellett has treated some parts of this subject in his chapter (q. v.) it will, perhaps, not be out of place to reconsider a few of them here.

It goes without saying that the cause of most of the accidents and complications that arise during and after cataract extraction are the result of defects not solely in the manipulative skill and carelessness on the part of the surgeon, but quite as often in lack of control on the part of the patient. Another cause of trouble is the undesirable local conditions referable generally to immaturity of the cataract, the septic condition of the eye or its appendages, or to lack of the usual aseptic precautions. Whatever has determined the unfavorable outcome of an operation it is of importance to the student to learn whether it has resulted from ignorance, carelessness or lack of thought on the part of any of those specially involved in the extraction.

In the preparation of the patient it is well not to instil too much cocain. Four or five drops applied to the conjunctival sac, at two or three minutes interval, are quite sufficient. Repeated and superfluous anesthesia reduces the tension of the globe, encourages bleeding from th conjunctival flap and may interfere with the healing of the wound.

Should the knife, or any instrument about to be used upon the eye, touch the skin, cilia or any other unsterilized part or object, it should immediately be exchanged for a clean instrument.

Entering the Knife Upside Down.

It occasionally happens that after the puncture or counter-puncture the surgeon discovers that he has *inserted his knife upside down.* It will be found that this accident is variously treated by different authorities. Knapp (Norris and Oliver, *System of Diseases of the Eye,* p. 800) recommends that the knife should be turned on its long axis so as to entirely reverse its position, and thus to continue the section. I had this exasperating accident happen to me once when using a long and quite thin knife on a deepset globe, and I was able to follow Knapp's suggestion. On the other hand I do not see how it is pos-

[104] Wicherkiewicz. Zur Frage der offenen Wundbehandlung nach Staroperationen. *Klin. Monatsbl. f. Augenheilk.*, Vol. XLII, 1904, p. 222.

sible, with a Graefe knife of average thickness, to accomplish this feat without considerable loss of vitreous and much damage to the cornea. On the whole it is better to withdraw the knife and wait until the original wound has healed.

Melville Black has invented a knife intended to meet this contingency. It is the usual cataract knife with a blunt point which is inserted into the original corneal opening with the proper edge up and the section completed.

Removal of Corneal Epithelium.

Since the introduction of adrenalin and cocain in extraction operations it is not uncommon after the expulsion of the lens to note corneal areas that have lost some of their protective covering. This re sult is undoubtedly due to the action of these remedies—especially of cocain—in softening the anterior epithelium so that even stroking the cornea with the delivery spoon suffices to detach portions of it. As a rule no serious consequence follows this accident, yet it cannot tend to the welfare of the eye and should be avoided by using no more of the local anesthetic than is necessary, by instructing the patient to keep his eyes closed during its action and by avoiding too much pressure on the cornea during the lens delivery.

Treatment of the Iris that has Fallen in Front of the Knife.

In simple extraction the iris occasionally falls in front of the knife. This complication generally arises as a result of improper manipulation of the instrument and usually when the cutting plane has been altered. In most cases it is best to proceed with the operation even though as a consequence, some irregular form of iridectomy be done.

Jameson advises (p. c.) that in the operation of simple extraction, *when the iris falls in front of the knife,* and ordinary manipulative methods fail in replacing it, a sharp, slender, javelin-pointed needle is made to pierce the cornea, as in figure 623. Once in the anterior chamber the needle can be swung against either border of the engaged iris or, the point being passed directly to the lower border of overhanging iris, it is lifted over the edge of the knife. This accomplished, the needle is pushed behind the knife so that it is interposed between the knife and the iris. The operator now proceeds with his incision and withdraws the needle immediately the iris is free. When the accident occurs, the fixation forceps is quickly handed to the assistant and the operator lifts the cornea on the flat of the knife, which is slightly rotated, and the needle manipulated as above described. The puncture of the cornea, after the chamber has been opened, is not always as easy a procedure as it would seem, and this method is not

adaptable in cases of collapsed and flaccid cornea. When carefully performed without laceration, the puncture does not interfere with healing, and when successfully performed, is preferable to a wounded, lacerated iris.

The Split Cornea.

When the point of the knife is not properly entered to make the puncture, this accident, as before mentioned, is very likely to happen. Of course, it endangers the success of the operation and invites all kinds of subsequent complications. Fortunately, the operator will notice the mistake that he has made and will be able to withdraw his knife before the anterior chamber is entered.

Another form of "split cornea" occurs when the counter-puncture is made. As shown in the figure, the point of the knife should be entered a little back of the apparent limbus as the light refraction gives it the appearance of being thrust farther forward than it really

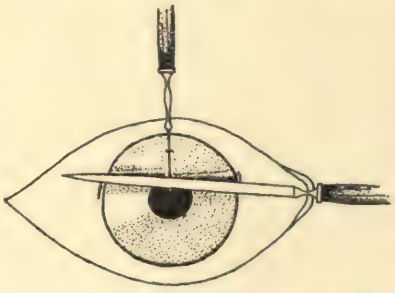


Fig. 623.

Jameson's Method of Replacing the Iris that has Fallen in Front of the Knife.

is. When a badly placed section is made in the cornea the wound edges do not heal kindly or properly. Not only is there much operative astigmatism but a wound infection of greater or less degree is likely to follow.

The foregoing accident ought to teach the same lesson. The operator should, before taking the first step, carefully review the various stages of the proposed procedure and endeavor, as much as possible, to recollect the idioms of cataract extraction. He should, as the result of experiment, both on the lower animals as well as on human subjects, observe the rules already laid down, especially for a uniform and proper corneal incision.

Stabbing the Iris.

Occasionally the operator thrusts the point of his knife into the iris while pushing that instrument through the anterior chamber.

Generally, this can be remedied by withdrawing the knife a mm. or so and disengaging it. He will then be able to make the counter-puncture without loss of aqueous.

Incomplete Sclero-Corneal Incision.

Experienced operators are generally conscious that they have not made the opening in the eyeball large enough for the extrusion of a large lens as soon as the corneal incision is complete, but beginners may not be aware of that fact until an attempt is made to extract the lens. When the lens cannot, with moderate pressure, be removed through the opening, it is better to enlarge it with scissors or Black's blunt-pointed knife (q. v.) than to bruise the tissues and detach soft matter by prolonged efforts to expel the cataract.

Collapsed Cornea.

When too much cocaine has been used, or in aged or weak subjects, a falling in of the cornea may occur, sometimes before the expulsion of the cataract. At this stage of the operation it need not embarrass the operator, but if the collapse happen after the removal of the lens a good plan is to fill the contracted chamber with warm, sterile, normal-salt solution, and this step may be carried out as a part of the irrigation of the anterior chamber after a preliminary removal of cortical remains, by stroking the cornea with the back of a spoon.

Air in the Anterior Chamber.

This need not be a source of alarm; indeed, I believe that entirely too much space is given in text-books to such an accident. The only importance that seems to me to attach to it is the possibility of the bubble, or bubbles, carrying infective matter into the anterior chamber. As I almost always use the simple irrigator pictured in this chapter, I do not find it difficult to expel the air bubbles. I much prefer this method to making attempts to squeeze the air out of the anterior chamber by means of a spoon.

Hemorrhage into the Anterior Chamber.

When the conjunctival flap is made too large there is always more bleeding from the severed sclero-conjunctival vessels than when the flap is properly cut. This accident, which not infrequently happens, is responsible for the most objectionable factor in operations done with a conjunctival flap. I believe that undue bleeding is also a result of prolonged, excessive cocainization and the too early use of suprarenal preparations. Better avoid the use of adrenalin until the last, or second last, drop of cocain is instilled. Then the hemostatic effects on the eye will be obtained at the proper moment, and there

will be less enlargement of the blood vessels which, I feel sure, almost always follows the use of these styptics.

As a choice of evils it is better not to manipulate the lips of the wound too much in an effort to expel blood from the anterior chamber. As before mentioned, after making the conjunctival flap, the whole eye should be gently flooded with warm boric acid solution, and the blood, in all its forms, coaxed out of the eye with dabs of cotton and by means of the anterior chamber syringe. A small quantity of blood remaining in the anterior chamber, as a rule, soon becomes absorbed and does little harm except to obscure, for the time, the intraocular field of operation. Sometimes, however, it becomes organized and forms one variety of after-cataract. In that case the use of *atropine* is indicated to prevent posterior synechiæ, and *dionin* to promote absorption of the deposit.

An Insufficient Cystotomy often a Serious Matter.

This defect in cataract extraction may generally be prevented by using a very sharp, almost needle-pointed cystotome and entering it carefully but firmly. Sometimes, even with the greatest care, the surgeon may not discover that he has to deal with an unusually tough capsule until the lens refuses to be expelled from its bed. In such cases it is best not to make too many efforts at cystotomy, but to use a pair of capsulotomy forceps provided with very sharp teeth. The instrument of Couper or Tooke (q. v.) will be found effective. If these fail then the extraction should be attempted as in the operation in the unruptured capsule; although a hook or some other traction instrument may also be used—but with care.

Button-Holing the Iris.

Even a careful operator, in his anxiety to remove as small a portion of the iris as possible, may find after the use of the scissors that he has made a "button-hole" opening in that membrane. This generally follows the seizure of the iris too near its base.

The iridectomy can still be carried out by passing in a Tyrrell's hook, drawing out the little band of uncut tissue and snipping it with the scissors. Herbert *(loco cit.,* p. 97) advises that:

"The narrow strip of tissue may be readily hooked upwards by the cystotome (held in the right hand) after the capsulotomy has been done. If very narrow it tears readily; otherwise the loop is released, and the forceps and scissors are again taken up. The forceps are used so that one blade passes down in front, and the other, generally more or less embedded in soft lens matter, behind the band. This will still be found lying near the wound, retraction being interfered with by the sticky lens substance. The points of the forceps being closed beyond the band, the latter may then be readily hooked up and cut away. Or if the eye be very unsteady the forceps may be dispensed with. The left hand may be usefully employed with the curette or expressing hook. Pressure is applied at the lower edge of the cornea, as for expulsion of the lens. The wound is thus forced open, and

the little band of iris stretched and carried forward on the presenting lens, either into the wound or near it, so that it may be easily cut with scissors. Usually the strip of iris may be made to present sufficiently well for the scissor blades to be applied transversely, snipping off lens substance together with the iris. Should by chance a long tag be left attached to one angle of the coloboma, this shrinks afterwards, but forms a posterior synechia."

Partial or Complete Dislocation of the Cataractous Lens During the Operation for Its Removal.

Cataracts affected with some degeneration of their cortex, nucleus or capsules, or, those with a diseased zonula, after the corneal section may sink into the vitreous, stick to the posterior surface of the cornea or become dislocated behind the iris. It is difficult to lay down rules for the management of these unusual excursions of the lens during its extraction, but the use of Taylor's vectis, a capsule hook or the wire loop of Weber will be found efficacious in most cases. Bourgeois *(loco cit.)* has described his method of removing the ordinary cataract by means of a fish-hook-like instrument, and I think that a similar procedure is about the best for dragging out of the anterior chamber these errant cataracts. When they sink deep into the vitreous the condition is a more serious one and the wire loop should be used at once, in the hope of reaching them before it is too late.

Immediate Prolapse of the Iris.

Immediate prolapse often, if not generally, means tags of capsule or vitreous between the lips of the wound, as L. Müller (Beiträge zur operativen Augenheilkunde, *Klin. Monatsbl. f. Augenheilk.*, 1902, p. 358) has shown. A fine, fibrillar, capsule remnant may hold the iris in this fashion and elude the curette or spatula used to free it.

Swanzy *(Diseases of the Eye,* 6th Ed., p. 373) recommends the routine search for such capsular, vitreous or cortical remnants. He passes the iris forceps into one angle of the incision and carries it along the whole length of the wound, repeatedly opening and closing it for the purpose of engaging and drawing out any tags that may be found. When caught, these are pulled out and cut off with scissors. Swanzy, in this way, has found capsule in the wound in about 25 per cent. of all cases.

Atropine Irritation, Dermatitis and Conjunctivitis.

This idiosyncrasy against belladonna shows itself in swelling of the conjunctiva and roughness of the palpebral skin. It is never accompanied by pain but generally is attended by some itching and ocular discomfort. It is commonly observed several days after the first instillation of the drug, and may be associated with considerable thickening of the skin surface and a sero-mucous discharge from the eye. It is an alarming sign to one who has not previously encountered

it but is not, fortunately, as serious a complication as it appears. The form of the mydriatic should be changed to duboisin or hyoscin, the dose reduced to the minimum and a simple ointment applied to the roughened lids.

Loss of Vitreous Before, During and After Extraction of the Lens.

The escape of vitreous at any stage of cataract extraction generally means *rupture* of the capsule, hyaloid membrane or suspensory ligament, combined or not with a fluid vitreous and increased ocular tension.

The pressure that excites it may, however, be *external*, such as by the lids, fingers, dressings or instruments. Sometimes the contraction of the straight muscles may be responsible for the accident.

Sometimes the vitreous may be present between the lips of the wound without actually entering it or without any subsequent escape of the fluid.

Loss of vitreous most frequently attends or follows the delivery of the lens, although it may take place as soon as the opening in the eyeball is large enough for its exit. It rarely occurs during the healing of the wound or after it has closed.

If the counter-puncture be too deep, or too peripheral a section has been made, the zonula is deprived of its usual support and loss of vitreous is all the more probable. Prominent eyes, as in high degrees of myopia or exophthalmus, are more liable to this accident than those normally set, mainly because the lids, in contracting, have a greater purchase upon the globe.

As has been said, the *immediate causes* of expulsion of the vitreous are spasm of the orbicularis brought about by any of the factors just mentioned that make the patient "squeeze up" the eye; too marked use of the fixation forceps; pressure or dragging of the capsule forceps or cystotome; a prolonged or too rapid section; an unexpected upward rotation of the eye when an instrument is in the anterior chamber; too much force employed in an attempt to expel cortical matter or capsular remnants; the difficulties already mentioned in attempting to cut through tough capsules, etc.

Treatment of Vitreous Loss.

Of course, the wisest plan is to prevent, if possible, this accident by avoiding all those conditions that predispose to or directly cause it.

When, however, the accident has happened it is advisable to cut away the projecting tissues with scissors. Even if this does not bring about an immediate adaptation of the wound margins it generally assists their readjustment within a short time. In performing this simple operation it ought to be done as quickly as possible, while the

patient is looking straight ahead or upwards; a downward fixation encourages the expulsion of more vitreous and should be avoided. Any iris that may also engage in the wound should be excised at the same time, without using iris forceps. No attempt should be made at fixing the globe, but the patient should be told to look up and keep as quiet as possible while the operation is being done.

In the majority of cases of vitreous prolapse this treatment generally ends in a resumption of the healing process, and in a day or so there is no evidence of the accident. The approximation of the wound edges is generally assisted by a light pressure bandage.

It sometimes happens that the vitreous becomes *incarcerated* in the wound, in which case the evil results are almost as bad as those noticed in prolapse of the iris, namely, post-operative astigmatism, iritis or iridocyclitis, opacities in the pupillary area, and the formation of bands in the vitreous. As in iris prolapse, also, wounds that contain vitreous remnants show evidence of this condition for an indefinite time after the healing of the scar. Indeed, an incarceration of the vitreous may lead not only to much the same post-operative conditions that one notices in iris prolapse but, in all probability, the deeper infections are more liable to happen than in uncomplicated iris prolapse. Among these are distortion, displacement and enlargement of the pupil, with or without hernia of the iris.

Opinions differ as to the gravity and dangers from loss of vitreous attendant upon cataract extraction. Henry Smith maintains that small losses are harmless, while other operators believe that every vitreous escape interferes with the smooth healing of the wound and invites subsequent distortion of the pupil and infection of the ocular interior. There can be no doubt but that the great majority of cases of vitreous loss during extraction of senile cataract do not materially endanger the success of the operation. On the other hand, however, many evil results flow from such an accident and the operator should ever be on the alert to prevent it.

Delayed Union of the Margins of the Incision.

One generally expects, and usually finds, union of both superficial and deep wounds in from seven to ten days after the extraction, but delay in healing is not uncommon. As a rule the interval is not greater than two weeks, but may be much longer.

The explanation of this phenomenon is not the same in each instance; it is said to result from frequent reopening of a partially healed wound; from the prolonged use of cocain; from poorly-nourished tissues; from defective reparative powers (Harlan[105]), and from the

[105]Harlan. Delayed Union after Cataract Extraction. *Annals of Ophthal.*, VII, 1898, p. 568.

formation of a *capillary fistula,* through the intervention of a few lens fibers or some of the lens capsule. In many instances there seemed no adequate explanation of the non-union.

Most observers have remarked the absence of infection in these cases that might reasonably be expected to invite such an attack; but the continual outflow of aqueous probably prevents it. However, Barck,[106] Maynard,[107] and others have reported cases of intraocular infection at least associated with delayed union of the wound.

Treatment.—When there is an obvious cause for this delay in repair of the wound it should, of course, be removed, but as a rule there is little to be done except to keep the parts clean and protect them, especially at night, by a light shield and dressing. In its own good time the wound will unite, the anterior chamber reform, the iris recede and the aqueous cease to escape.

Frank Allport (p. c.) employs superficial cautery of the wound edges with some mild escharotic; other surgeons use the galvanocautery, while still others advise freshening the incisional margins by means of a sharp spatula or curette.

Expulsive Hemorrhage.

This is one of the most dreadful accidents that can happen to any patient and although it is exceedingly rare, is always feared by the operator. de Wecker has reported 8 serious hemorrhages in 3,000 operations, while Sattler saw only 4 in the same number. The bleeding may occur in any operation that involves the opening of the eyeball, iridectomy, for example, but it is in cataract operations that it is more commonly seen and dreaded. The blood invariably comes from a ruptured choroidal vein. It collects between the sclera and choroid and eventually ruptures the latter. It occurs mostly during operation but there are cases on record in which it has set in several hours or even days afterwards. The corneal flap is slowly pressed forward, vitreous presents in the wound, the zonula ruptures, the bleeding shows externally and after the expulsion of vitreous, and a blood clot, the detached retina and choroid follow. The dressings are found to be soaked with blood, the lids are generally swollen and in the corneal wound is seen a large blood clot. Of course, such an eye is irreparably lost.

All sorts of causes are mentioned for this unfortunate accident. These are mainly extractions in a glaucomatous eye, hemophilia, disease of the choroidal blood vessels, etc. The *exciting cause* is

---

[106]Barck. On Retarded Closure of the Wound, and Some Rare Accidents and Sequelæ of Cataract Extraction. *Am. Journ. of Ophthal.*, Sept., 1897, p. 281.

[107]Maynard. *Manual of Ophthalmic Operations*, p. 112.

anything that brings strain upon the eye, the sudden decrease in the normal intraocular pressure, venous hyperemia from vomiting, strain of coughing, etc.

The *treatment* of such a case is not of much avail. A pressure bandage may be applied, and protruding remnants of choroid, retina, vitreous, etc., snipped off. Ice has been applied and writers on the subject have suggested hypodermic injections of morphin, adrenalin, and even ergotin in the usual solutions. Some surgeons give 15 grains of calcium chloride every hour. Others advise an immediate use of a scleral-corneal suture. Finally, when no treatment avails, evisceration, packing the eyeball with gauze, or enucleation, is indicated.

Far better than the treatment of a case is *prophylaxis*. This consists of any measure calculated to minimize the tendency to choroidal rupture, such as a suitable diet, purgation, iodides and, perhaps, gelatine injections (q. v.). A preliminary iridectomy is indicated in suspected cases and the section should be made as slowly as possible so that the tension of the eye may not be diminished too suddenly. Of course, complete rest should be maintained after the operation.

Post-Operative Iritis.

This process is probably always associated with irritation or inflammation of the rest of the uveal tract—especially in the severer forms. It varies greatly in intensity, from the simple form due to mechanical irritation of the iris, caused by retained lens matter, to the most pronounced cases in which direct infection is the evident source of the inflammation.

Herbert *(loco cit.,* p. 285) warns us against leaving in the anterior chamber the "milk" of Morgagnian cataract, which acts as a decided intraocular irritant.

Among the other causes are *(a)* too long or too forcible irrigation of the anterior chamber, or lavage with any fluid but sterile, dust-free, normal salt solution at the body temperature; *(b)* operative traumatism, such as occurs in tearing or bruising the iris with dull instruments, in the forcible expression of the lens through a too small section and in dragging on the membrane by the iris forceps when the patient suddenly rotates the globe; *(c)* injury to the eyeball during careless nursing, by a badly fitting mask or dressing, by a finger-thrust or by some injury received during sleep; *(d)* more rarely as a part of the recurrence of a diabetic, syphilitic or rheumatic process.

The *symptoms* generally set in several days after the operation—*the later the milder*. These are, at first, slight lachrymation, edema of the lids, pain (generally worse at night), slight photophobia and evident ciliary congestion. The pupil is, as a rule, contracted and is not

readily affected by atropia; the iris undergoes color changes and there is nearly always some lymphoid exudation.

These signs of the disease persist for a variable period, most cases recovering under atropia, hot applications, Credé's ointment and dionin.

When the inflammation persists a complete course of mercurials, with or without sweats, is indicated. The efficacy in some cases of subconjunctival injections (q. v.) should not be forgotten. I have much faith in salicylates when given as Gifford (q. v.) prescribes.

Even when the pupil eventually becomes occluded some form of secondary operation may restore much of the lost vision. These interventions are not to be allowed, of course, until the eye has become entirely quiet, and their success is more than doubtful should the globe have meantime become soft or if it remains for any great length of time tender to the touch. In such cases one may suspect a deeper involvement of the uveal tract.

Post-Operative Iridocyclitis.

This formidable disease may generally be regarded as a more pronounced form of infection than that described under *iritis* and is, as a rule, followed by complete loss of useful vision. Cases present, within 24 hours after the extraction, the symptoms of acute iritis followed soon by marked evidence of an intraocular inflammation, i. e., a blurred, swollen iris with exudates at its margins.

In spite of all *treatment* (which is substantially that suggested in the severer forms of iritis) the pupil generally fills with fibrinous masses, there is an updrawn pupil and, finally, an *iris bombé*. Now and then, however, the eye becomes quiet and some form of iridotomy (q. v.) may eventually be instrumental in restoring a fair amount of sight.

Infection of the Operative Wound.

In spite of our boasted improvement in asepsis and antisepsis infections remain the most serious complications of cataract extraction. Although, as in advanced anemia, arterio-sclerosis, lachrymal disease, etc., one is obliged to run certain unavoidable risks, yet definite microbic invasions of the operative wound are, after all, the *bête noire* of the surgeon. The time and the occasion may vary from the moment of the puncture that opens the anterior chamber to weeks or months after the operative wound has healed, but the admission of bacteria or toxins, or both, to the interior of the eye will generally account for the majority of post-operative disasters. It is not intended to deny the verity of endogenous infection or to minimize the lowered resistance of the tissues that is not infrequently encountered in old people with nephritic and other organic changes, but these facts should not be allowed to cloak a more important factor—septic infection.

The most common *predisposing* cause of bacterial invasion is prolapse of the iris, prolapse of the vitreous and the incarceration of portions (however minute) of these and other tissues between the lips of the wound. Such accidents, as well as an irregular corneal cut, prevent that clean, smooth and early adhesion of the incisional margins that is the best guaranty of a successful operation.

Treatment.—It is always safe, where the iris is not perfectly active and clear on the day following the operation, to instil four or five times during the 24 hours, two drops of a 1 per cent solution of atropine. At the same time a purgative should be given, and an effort at once made to discover the cause of the iritis. Once this is done it is often possible to prevent further progress of the disease. Should the inflammatory conditions continue for a few days all bandages should be removed from the eye and a 5 per cent solution of dionin combined with the local atropine treatment. I am much in favor of the Gifford method of using salicylates, it matters not what the underlying cause of the iritis may be.

Some surgeons find considerable value in sub-conjunctival injections of a 1 per cent salt solution. The cyanide and other salts of mercury I do not believe give much better results.

In conjunction with these local and general measures, the conjunctival sac may well be irrigated with 1-10,000 bichloride two or three times a day, followed by the use of White's ointment. Hot fomentations and Leiter's coil will generally relieve pain. At this stage of the inflammation, and when cyclitis is suspected, I generally apply Credé's ointment to the lids at night-time. Reference has already been made to the applications of the electro-cautery to the wound margins in evident infection of the incision.

Suppuration of the Extraction Wound.

This is by far the most serious calamity that can involve the eye operated on, as it almost always terminates in panophthalmitis and complete loss of sight. Following the rule of post-operative infections the involvement of the eye shows itself within a few hours after the patient is put to bed and the signs of the accident are quite marked. The pain in and about the eye is severe, the swelling of the upper lid is pronounced, the globe is very tender, the secretions are copious and the cornea is decidedly steamy. The wound margins sooner or later become swollen, whitish-yellow and exude a purulent discharge. Hypopyon is seen and the anterior chamber soon fills with the exudate. In spite of all treatment the invasion of the cornea and iris continues and most of the former melts away as a part of the destructive process. Finally, the vitreous is infected, the wound opens widely and the picture of a panophthalmitis is complete.

The *treatment* of this condition is of little avail, but in addition to the applications just mentioned, the introduction of iodoform *coloids,* or Haab's discs, may be tried in conjunction with deep electro-cauterization of the wound. Kuhnt's plan (q. v.) of scraping the infected wound margins and then covering them with conjunctiva may also be worth a trial.

The propriety of enucleation (or some substitute for it) in the face of an eye destroyed by this deep infection is fully considered by Dr. Allport. In my opinion, it should not, in the interests of the fellow eye, be long delayed.

POST-OPERATIVE OR LATE COMPLICATIONS OF SENILE CATARACT EXTRACTION.

This section should be read in conjunction with Dr. Ellett's chapter on the subject of post-operative complications in general. I have supplemented his remarks by discussing the chief processes and diseases one may encounter any time after the patient has passed through the first operative ordeal.

Doubtless there are extractions in which no forethought and no surgical skill can prevent an untoward result, yet it must be admitted that lack of experience on the part of the operator, inadequate ante-or post-operative measures (including insufficient aseptic precautions) and defective technique, one or all, pretty well explain the great majority of failures to improve the vision of a cataractous eye. Indeed, a consideration of the means by which unfortunate terminations of this important operation may be avoided leads us inevitably to the principles repeatedly stated in these pages, *a proper technique faithfully carried out in an eye fit for operation.* It is not enough to have the instruments, hands and operative field aseptic and kept aseptic until the healing of the operative wound; the extraction itself should follow the lines proved to be correct by experienced operators.

Post-Operative Opacities of the Cornea.

Under the titles *striped keratitis, filamentous keratitis* and *post-operative keratitis,* various forms of streaky cornea are described. I have seen it a number of times after irrigation of the anterior chamber and have believed it to be due to injury of the endothelium from improper lavage. It cannot be too often repeated that although a most valuable assistant in freeing the ocular interior of irritant particles care should be taken to do the irrigating gently and with dust and germ-proof fluids indifferent to the eye and of a temperature kept as near 100° F. as possible.

Other forms of corneal traumatism are also said to be responsible for these linear opacities of the cornea, such as tight bandages, the too

free use of instruments and the squeezing of a large lens through a narrow section. The hazy lines sometimes assume the form of patches or well-defined nebular areas.

There is no special treatment for any of these conditions; they usually disappear in a week or two, although I have seen two cases with nebulæ in which the cloudiness persisted and greatly reduced the vision.

Incarceration of the Iris in the Wound of Operation.

Prolapse or hernia of some part of the iridic tissues is more common in the simple than in the combined operation but in either procedure may be followed by inhealing or incarceration of the iris as a serious after-complication.

When prolapse occurs it almost invariably shows itself during the first day after the extraction. This fact justifies, as I have before said, the critical but careful examination of the eyeball twenty-four hours after the completion of the operation. Better results probably flow from the immediate treatment of early prolapse than to leave it for future consideration.

The *extent of the prolapse,* as well as the *degree of incarceration* of the iris, varies from a mere linear adhesion to some part of the wound edges to the extrusion of one or more knuckles or folds of iris.

The *causes of prolapse* are chiefly injury to the parts or any violence that may reopen the wound. Sneezing, coughing, straining at stool and vomiting are among these, as well as accidental blows on the dressings, finger thrusts, squeezing of the lids, sudden movement in or out of bed, undue pressure of the bandage, mask or shield, etc. Sometimes the normal intraocular pressure exerted by the mass of the vitreous on the iris appears to explain some forms of prolapse.

Extreme care should be exercised in removal of the dressings at the first few inspections of the eye following an extraction because, as Swanzy and others have shown, the iris may be washed or pushed into the wound by the sudden outflow of aqueous induced by the opening of the lids and the consequent disturbance of the wound edges. This fact brings home to one the reasons for the numerous operations devised by operators to provide such a sluice-way (iritomy, iridotomy) for the escape of aqueous as will permit effective drainage without carrying the soft tissues with it. It explains the more frequent occurrence of prolapse in the simple operation, as well as the value of the conjunctival flap in all operations.

Among the *predisposing* causes, apart from an intact iris, are paresis of the iridic muscular fibres due to injury or to the force employed in expelling the lens; a needlessly wide iridectomy and the presence of cortical remains in the anterior chamber.

If we are to draw any conclusions from the statistics of operators iridic prolapse must be an exceedingly variable incident. Marshall's figures (in 1,091 cases) give 13.87 per cent. in the simple operations as performed at Moorfields, and 0.87 per cent. for the combined procedure. Galezowski reports prolapse in one-half of one per cent. in 200 simple extractions; Herbert, 8.37 per cent. in 490 simple cases; Swanzy 1.13 per cent. in 354 operations with iridectomy.

Sequelæ of Iris Prolapse and Incarceration.

That part of the prolapsed iris, whether it be large or small, that shows outside the eye is soon covered with lymph and adheres to the surrounding tissues. If not replaced or excised the iridic pigment before long begins to undergo absorption so that the whole membrane is really thinner than normal, while through all—exudate, iris and such proliferating epithelium as grows from conjunctiva or cornea—the aqueous slowly filters. Indeed, a *filtration area* is here established which often lowers the intraocular tension and may act as a safeguard against glaucoma, as that disease is often seen in iridic hernia.

A *distorted* and *displaced* pupil is a common sequel of an incarcerated iris. Not only is the pupil often drawn quite up to the half-formed scar *(cystoid cicatrix)* but its area is likely to be more or less occluded from iritic deposits.

Such a condition is a continual invitation to toxic and bacterial invasion of the intraocular tissues, and years after the operation uveitis and sympathetic ophthalmia may result from infection of the interior of the globe.

Although a conjunctival covering is a hindrance to and may entirely prevent these evil consequences of prolapse and hernia of the iris yet it must not be forgotten that even after *superficial healing* has taken place the *deep wound* may be prevented from uniting and so admit a part of the iris between its lips. In such cases there is probably a foreign body (capsular fibril or cortical remnant) wedged in between the lips of the deep incision.

If the hernia of the iris be *wide* a considerable amount of *astigmatism* is the result, and as this anomaly is likely to be of the irregular variety a serious interference with vision is certain to follow.

To add to the discomforts of the patient the uneven surface of the globe prevents the lid edges from performing their proper cleansing function; mucus, harboring bacteria and fouled with toxins, is insufficiently wiped off the eyeball and both *conjunctival and ciliary irritation* is a common consequence.

The *treatment* of iris prolapse should precede that for secondary cataract, to avoid, as much as possible, loss of vitreous. If the prolapse be observed within the first twenty-four hours (when the great

majority of them happen) the eye should be cocainized, *thoroughly disinfected* and an attempt made to replace the errant tissue with the stream from an irrigator or by means of a spatula. This reposition should be followed by the use of eserin and the question may well arise as to the advisability in the particular case of resorting to the conjunctival flap of Kuhnt.

After the prolapse has assumed the condition of an actual incarceration, or has been exposed to external infection for several days, *excision* is the proper proceeding. The longer the interval between the prolapse and the operation the greater the difficulties to overcome. The wound is irritable, the eyeball tender and the iris congested; cocain has little effect and neither fixation forceps nor speculum can be used for fear of vitreous loss. The eyeball and sac should be thoroughly irrigated with hot normal salt or boric solution, followed by the use of cocain and adrenalin. Herbert suggests the application of a few crystals of cocain to the wound.

The lids are now firmly separated by an assistant (or a retractor is used) and the extruded fold of iris firmly seized and drawn out by a pair of fine iris forceps. This act is always painful and the excision of the iris with the scissors (well pressed against the globe) should follow almost simultaneously. Otherwise the patient suddenly and forcibly rotates his eye upwards, the opportunity to excise the part is lost and the end of the iris forceps is in danger of bruising the wound edges or even of being forced into the anterior chamber.

Should the conjunctival flap cover the prolapse the former may be turned back with forceps and the operation carried out as just indicated.

After an early performance of this operation the edges of the iris wound may fall well into the anterior chamber and form the ordinary coloboma of an iridectomy, but in any event the excision generally exercises a good influence on the incarceration as a whole; the mass of tissue about the wound generally contracts and a flat scar is the final result; which is better than if, as some surgeons suggest, the incarcerated tissues be left undisturbed. However, the dangers of late infection are still by no means unreal, while the cosmetic and visual results are not flattering. Here, even more than in early prolapse, are the protective conjunctival flaps of Kuhnt and others to be recommended.

On rare occasions it is possible to sever (as in the operation for anterior synechiæ) the connection between the intraocular portions of the prolapse and the deep wound, by Lang's twin knives. When this is accomplished the extraocular tissues may be excised or even seared with the galvano-cautery. I have hesitated to use the latter remedy

even in small uncovered prolapses owing to an untoward result encountered in public practice some years ago.

Prevention of Iris Prolapse.

The literature of this subject is so extensive that it is impossible to refer even to the most important part of it here, especially as the essentials have already been discussed. There are, however, a number of procedures intended to prevent prolapse of the iris that should be considered.

Bell Taylor *(The Lancet,* Vol. 2, 1871, p. 802), extracted cataracts through an opening in the base of the iris (so made as to leave the pupil quite untouched) to guard against prolapse and hernia of that organ. He made a small but peripheral iridectomy which was enlarged by a cut with fine scissors on each side. The objection to this method is its complicated technique, the difficulty in expelling the lens through a small opening and the subsequent distortion of the pupil.

Schweigger did a basal iridectomy in conjunction with a downward corneal section for the purpose of preventing iridic prolapse. As elsewhere stated, these openings in the iris generally close completely and, no doubt, assist in preventing a subsequent hernia of the iris.

After, or Secondary, Cataract.

Following the great majority of simple and combined cataract extractions some opaque matter—generally membranous—can be found in the anterior chamber. A description, as well as the conduct of these cases, is well set forth in the Chapters of Drs. Callan and Standish and to these authors I would refer the reader for a consideration of, perhaps, the most important complication of senile cataract extraction.

Glaucoma Following the Extraction of Senile Cataract.

Although the occurrence of any form of post-operative glaucoma is so rare (two to three per cent.) as to give rise to a suspicion that we mostly have to deal with the *revival* of an old process, or with a pure *coincidence,* there is no doubt but that the altered conditions introduced by the operation are sometimes responsible for the increased tension and other symptoms. Moreover, the fact that it shows itself more frequently in the combined than in the simple operation argues in favor of a true operative glaucoma. The iritis, uveitis, posterior synechiæ, occluded pupil, etc., known to produce glaucoma apart from operation may also set it up in association with an extraction. Added to these causes are others that block the canal of Schlemm or the sclero-iridian angle. Among them are displacement of the margins of the coloboma forward, pressing the root of the iris against the angle, proliferation into the anterior chamber of the corneal and conjunctival

epithelium, tags of tissue caught in the incision and dragging on the iris and ciliary body, as Parsons[108] claims, and direct stoppage of the filtration current by cortical and other debris.

The *treatment* of a disease due to so many different causes must, of course, be regulated by a strict enquiry into its origin in each case. The increased tension in *glaucoma* generally subsides for a time after a paracentesis; if the conditions are favorable an iridectomy may be done forthwith. Inflammatory conditions are better treated by dionin and atropia than by eserin. Division of membranes that occlude the pupil or drag on any part of the uvea is indicated. The formation of a filtration cicatrix after the plan of Lagrange or Herbert (q. v.) is to be advised in glaucoma following the combined operation. When judiciously applied the treatment of this complication is as successful as in glaucoma not associated with cataract extraction.

Choroidal Detachment.

Detachment of the choroid as a complication of cataract extraction was first reported by Knapp (1868). Recently it has been studied by Fuchs[109] who attributes the accident to the passage of aqueous through minute tears at the filtration angle into the suprachoroidal space. Thomson Henderson[110] believes it to be essentially a passive serous collection in this locality due to low ocular tension the result of a leaking wound in the eyeball.

It is difficult to say whether this condition is of rare or frequent occurrence as it interferes little with vision, is rarely permanent and disappears when the incisional wound heals and the eye regains its normal tension. Separation of the choroid varies much in extent and duration. It generally affects the lateral quadrants of the eye and does not extend beyond the exits of the *venæ vorticosæ*. As it occurs during a time when one does not usually care to disturb the eye by a rigid ophthalmoscopic examination, and as the detached portion is of the same color as the rest of the fundus, it is not easy to make out its dark, curved, posterior boundary, while even the displaced retinal vessels may escape notice. The treatment of this peculiar condition is bound up with that of the minus tension that gives rise to it.

Detachment of the Retina After Cataract Extraction.

The conditions under which the operation is responsible for retinal detachment have not been clearly defined by writers on the subject except to say that it may be expected and is mostly caused by large loss of vitreous. It seems rational to expect it in those cases,

---

[108] Parsons. *Pathology of the Eye.* Vol. III, p. 1083.

[109] Fuchs. *Archiv f. Ophthal.*, Vol. 51, 1901, 2, p. 199.

[110] Henderson. A Histological Study of the Normal Healing of Wounds After Cataract Extraction. *Ophthal. Review*, 26, 1907, p. 127.

of which Treacher Collins has described several, where there is adhesion—direct or indirect—between the hyaloid and the wound of incision. In highly myopic eyes one may look for it, especially after rupture of the posterior capsule, loss of vitreous or after sudden expulsion of the cataract. It is also a genuine result of advanced iridocyclitis due to faulty extraction and infection. Yet retinal separation is a comparatively rare complication of extraction and its prophylaxis and treatment do not differ from cases encountered in other connections.

Visual Results After Senile Cataract Extraction.

It cannot, of course, be expected that the (elderly or aged) patient will have any better sight after the removal of the lenticular obstruction to vision than he would have had at the same period of life in the absence of cataract and yet normal vision is not uncommon after cataract extraction. The patient often recovers excellent distant sight, reads the finest print, becomes reconciled to the loss of his accommodative range and seems to have taken a new lease of life. It must be remembered, however, that secondary changes in the posterior capsule may, later, lower the visual acuity and that other causes may breed dissatisfaction with the primary result, but as a rule the extraction of senile cataract, carried out with a rational conception of its responsibilities, is a procedure preëminently satisfactory to both patient and surgeon.

Since statistical results are very misleading, if for no other reason than that they depend upon extreme variableness in the factors that compose them, I am not inclined to quote them to any extent, except to say that one might count himself a good surgeon with *three per cent. of eyes lost* (or vision nil) generally from irremediable iridocyclitis, glaucoma, panophthalmitis, expulsive or severe intraocular hemorrhage, vitreous opacities and detached retina.

Poor results (in which the best vision obtainable is less than 6/60 or 20/200) *should not exceed seven per cent.*, mostly due to closed pupil, uveitis of varying degrees, iritis with anterior or posterior synechiæ, glaucoma, squint, loss of vitreous, vitreous hemorrhage, corneal opacity, retinal detachment, thick membranes in the pupillary area and iridic prolapse.

Seventy per cent. of the cases operated on should have *good vision*, with the ability to read ordinary print and to follow the occupations proper to the age and station in life of the patients.

Between what I have called "good" vision and "poor" vision lies an uncertain and debatable category of twenty per cent. a part of which would be regarded by the optimist as examples of satisfactory vision or good sight; by the pessimist as poor vision and a failure of operation.

Post-Operative Astigmatism.

This anomaly, according to Treutler, (Ueber die Krümmungsänderungen der Hornhaut nach Star-operationen, *Zeitschr. für Augenheilk,* June, 1900, p. 484) is due both to vertical flattening of the cornea and to increase in the horizontal curve. In some cases the astigmatism, found a fortnight after the operation, persists or is even increased later. In other cases it diminishes somewhat or may entirely disappear in the course of a few months. This reduction may be ascribed to a readjustment of the wound surfaces which had been displaced by over-riding of the corneal flap. In sclero-corneal sections it may be that the down-growth of epithelium interposes a wedge between the wound edges and keeps them apart. For this reason *the abnormal curvature is generally greater in sclero-corneal sections than in those that are made entirely within the clear cornea.*

Jackson *(The Ophthalmic Review,* Vol. 12, 1893, p. 349) found that in 15 per cent of cases a permanent degree of astigmatism was reached within two months after the operation; in 20 per cent. regressive changes continued after more than three months.

Rollet (Résultats éloignés de l'opération de la cataracte sénile, *Revue gén. d'Ophtalm.,* June, 1904, p. 241) found that in examining 150 cases, five months after the operation, 25 per cent. exhibited no marked astigmatism, while the remainder had an average amount of 2.57 D. A year or more after the extraction there was either complete disappearance of the astigmatism or a small amount (at right angles to the original) had developed.

Colored Vision After Senile Cataract Extraction.

Although *erythropsia* is an occasional complaint, especially after the patient has first been exposed to bright light, other forms of anomalous color sight are rare. It has been especially noticed after a broad iridectomy and is supposed to be caused by the ultra-violet rays which are, in normal eyes, largely shut off by the lens.

Cyanopsia is another form of color vision noticed after cataract operations but it is generally transient in character. Probably it occurs even more frequently than erythropsia but as it generally lasts but a short time is not noticed by the patient. As a rule, all forms of color vision disappear within the first month after the extraction.

Flatulence and Other Forms of Indigestion.

In my experience this is the most constant and most annoying of the less formidable systemic after-effects of the operation. In consequence of the accompanying insomnia, nervousness, pains in the back and general malaise it has its serious aspects, and may indirectly contribute to a poor result or even to decided loss of vision. It can gen-

erally be avoided by taking the precautions noted under the immediate after-treatment of normal cataract extractions in this chapter. The lumbar pains are mostly from tired and stiff muscles, the result of cramp and fatigue, due to fear felt by the patient of turning in bed lest he injure his eye.

Mental Disturbances Following Senile Cataract Extraction.

The possibility of delirium, hallucinations, mania and allied symptoms after a cataract operation has already been spoken of. The mental balance of old people is especially prone to be disturbed by putting them in a dark room of a strange hospital, to say nothing of the anxiety connected with a serious operation.

The possibility of *delirium tremens, insanity, atropine poisoning* and even of *sudden death* in these senile subjects should not be forgotten.

The majority of mentally disturbed patients recover under sedatives and judicious moral suasion. In every case the condition of the bladder, bowels, urine, blood, etc., should receive attention. Care should be exercised to prevent a temporarily insane patient from tearing off the bandages and otherwise injuring his wounded eye.

CHAPTER IX.

THE INTRACAPSULAR EXTRACTION OF CATARACT.

By D. W. GREENE, A. M., M. D., Dayton, Ohio.

Historical Review—Daviel's Operation—Sharp's Operation—Richter—Beer—The History of the Modern Intracapsular Operation—Christiaen's Operation—Sperino—Pagenstecher's Operations—Landesberg's Form of Extraction in the Capsule—Wright's Operation—Andrew's Method—Fox's Operation—Savage's Detacher—Gradenigo's Capsulo-lenticular Extraction—Cassiani's Operation—East Indian Methods of Capsulo-lenticular Extraction—Mulroney's Method—The Henry Smith Operation—The Jullundur Clinic—The Technique of the Smith Operation—The Instruments Used in the Intracapsular Operation—The Author's Method of Cataract Removal in Its Capsule—The Section the Chief Consideration—The Iridectomy—Expression of the Cataractous Lens—Straight Delivery—"Tumblers"—The Jullundur Toilet—The Author's Toilet—Summary.

Intracapsular cataract operations are of three kinds. First, by which the cataract is delivered by pressure applied to the outside of the globe; second, by which the cataract is delivered by an instrument passed into the eye behind, to scoop or draw it out or break up its zonular attachments by pressure on the anterior face of the lens; third, by which the cataract is delivered by a combination of the two preceding methods.

The first and third methods are described by Henry Smith (q. v.); the second method is best exemplified by the original Pagenstecher operation.

Historical Review.

There is no unanimity of opinion as to who, with design and purpose, first extracted a cataract in its capsule.

It is generally believed[1] that Daviel,[2] among the different methods he tried, did the intracapsular operation. He says:

---

[1]In preparing this chapter I have drawn liberally from what I have written in several previous papers, under the following titles: Visual Results After Cataract Operation. *Ohio State Med. Journal*, Sept. 15, 1906; Extraction of Cataract Within the Capsule. *Ophthalmology*, Vol. III, Jan., 1907; Further Experience with the Smith-Indian Operation in the Extrac-

"The case which had fallen into our hands (referring to the well known case of the Hermit, of Provincia) made me form the resolution not to operate any more except by opening the cornea and thence to reach the *lens in its capsule* in order to make it pass through the pupil into the anterior chamber and thence to remove it from the eye." The context shows that he did not succeed in the case referred to, but it is clear that he had the idea in mind.

Sharp,[3] an English surgeon born in Jamaica, was one of the first to extract the cataract in the capsule, a fact that seems to be well established by his description of the operation he performed:

"Place the patient in the same situation as for couching. Either open the eyelid with your forefinger and thumb or, better, an assistant may raise the upper lid while you yourself keep down the lower lid. Then with a small knife, holding its edge downward, make a puncture through the cornea near its circumference into the anterior chamber of the eye in such a direction as to carry it horizontally and opposite to the transverse diameter of the pupil; after which you are to pass it towards the nose through the cornea within or outward as near to its circumference as in the first puncture. When you have made the second puncture push the extremity of the blade one-seventh of an inch beyond the surface of the cornea, and immediately cut the cornea downward, drawing the knife towards you as you make the incision. After this *you press gently with your thumb against the inferior part of the globe of the eye in order to expel the cataract*, and the operation is finished according to the different circumstances, as in the manner proposed by Mons. Daviel."

According to Hubbell, Sharp operated without fixing the eyelids, and without a speculum. He delivered the lens in its capsule.

According to Arlt[4]: "The thought came to Sharp first to remove the lens in its capsule," and he also said in the same connection: "If we possessed a method whereby it would become possible to remove the entire lens we would be called upon to report less losses and still less unsatisfactory results." He further said, "I have shown that it is possible to remove the lens in its capsule without loss of vitreous in cases where the capsule is cloudy and thickened."

Richter,[5] a little later, proposed extraction in the capsule in the following manner. He passed the point of a round needle through the sclerotic into the posterior chamber and impaled the lens on it, then

---

tion of Cataract. *Ophthalmic Record*, Oct., 1908; Experience in the Expression of Cataract in the Capsule. *Jour. Am. Med. Assocn.*, Vol. LIII, pp. 777 to 782, Sept. 4, 1909; The Smith Operation Toilette and After-Treatment. *Ophthalmic Record*, Feb., 1910; and The Modified Smith Operation. *Trans. Amer. Acad. of Ophthal. and Oto-Laryn.*, Sept., 1910.

[2]Daviel. *Mémoires de la Académie de Chirurgie*, Vol. II, p. 337.

[3]Hubbell. Sharp, the first Surgeon to make the Corneal Section in Extraction of Cataract with a Single Knife. *Trans. Am. Acad. of Ophthal. and Oto-Laryn.*, p. 51, 1904.

[4]Arlt. Graefe-Saemisch. *Handbuch der gesamten Augenheilk.*, Vol. II, p. 261.

[5]Richter. Abhandlung von dem Ausziehen des grauen Staars. Goettingen, 1773; Von einer neuen Art den Staar Auszuziehen. *Observationes Chirurgicales*, Goettingen, 1776. Fact. II.

by moving the handle from side to side and from above downward, and lastly by rotating the lens so as to break up any remaining attachments to the zonula or to the hyaloid he pushed the lens in its capsule forward through the pupil into the anterior chamber from which he extracted it by a lower section and without iridectomy.

It would be useless to attempt to name all the other early operators who have contributed to the development of the operation, but there are operators other than Daviel, Sharp and Richter who have been so closely associated with the development of the intracapsular operation that the study will not be complete unless they are mentioned and their respective methods referred to.

Morenheim,[6] in 1781, suggested that the attempt be made, after completion of the corneal section, to deliver all cataracts in their capsule by light pressure on the globe.

In 1799 G. J. Beer[7] advised impaling the lens in its capsule, from behind, on a needle as Richter had done more than twenty years before. "Two indications are given by which the tearing of the zonula of Zinn is found easy for intracapsular extraction for cataract. The first is a cataract with a large nucleus and a small quantity of tenacious cortex. The second is an unripe cataract with a large nucleus ripening slowly, which is most frequently found in myopic eyes."

Arnemann[8] extracted the cataract through an upper section made with a Beer knife and expelled the lens by a double-ended instrument, one end shaped like a Daviel curette, the other having a spiral tip like a corkscrew for impaling the lens through the pupil and drawing it out of the eye. This operation seems not to have met with favor. It was severely criticised by Himly and Schmidt[9] as dangerous to the eye and not based on sound surgical principles.

History of the Modern Intracapsular Extraction.

Little progress was made in the development of the operation until 1845, when Christiaen conceived the steps of the modern intracapsular operation as the rational procedure. He described them as follows:

"The patient is placed on a chair near a window and in such a position that the light falls upon the eyes from the side, and is not reflected by the transparent cornea. An assistant fixes the head against the left side of the chair if I operate on the left eye, and against the right side if the right eye is to be operated on. In the first case the assistant places his right hand under the chin and approaches more or less near the surgeon, who is

[6]Morenheim. *Graefe-Saemisch Handbuch der gesamt. Augenheilk.*, Vol. II, p. 284.

[7]Beer. Eine Methode den grauen Staar sammt die Kapsule auszuziehen, Wien 1799.

[8]Arnemann. *Systéme de Chirurgie*, Goettingen, 1801, p. 151.

[9]Schmidt. *Ophthalm. Biblioth.*, Vol. III, S. 3, p. 181.

in front of the patient seated or standing. He then puts the palm of the left hand over the left side of the patient's forehead in such a manner that the extremity of the index and middle fingers shall reach a little below the side of the lower eyelid. By means of an elevator he lifts up the eyelid as much as possible and immediately applies the middle finger to fix it more solidly. He must take care that the end of his finger is sufficiently removed from the eyeball so as not to touch it and exert no pressure upon it. The disposition must, nevertheless, be such that if the eye flies upward under the instruments the projecting part should meet and compel the organ to resume its position.

"The operator in order to look from above downward into the interior of the eye and not be obliged to hold his arms raised must place himself before his patient in such a position that his chest is on a level with the patient's head. He lowers the inferior eyelid with the index finger (of the left hand for the left eye, of the right hand for the right eye), taking care that the extremity of this finger, as that of his assistant, is on the palpebral level; he applies the middle finger over the lachrymal caruncle so as to prevent the escape of the globe to the internal angle—a very serious inconvenience. He seizes the keratome, which he holds like a pen between the thumb, index and middle finger, the cutting edge being in the direction of the incision, upward, downward or obliquely, the point three or four millimeters from the cornea. The ring and little finger rest against the cheek. The instrument is now plunged at the point of election and the cornea traversed with one cut. Once the point of the knife has appeared at the nasal angle it is fixed over the nail of the index finger which depresses the eyelid, and which now serves to conduct the gradual completion of the section, and at the same time by a light pressure upon the upper eyelid the exit of the lens in its capsule is determined.

"After allowing the eye to rest a minute one assures himself whether the edges of the wound are in coaptation and if the capsular fragments are not engaged against the lips of the wound, a circumstance the author has observed, though rarely.

"If it happens that the lens remains, as usual, in place at the completion of the corneal section, he raises the upper eyelid and by lowering the lower eyelid, brings to bear the flat of the curette over the upper part of the eyeball and by a few compressive movements brings about the exit of the lens.

"The anterior capsule is not incised and the extraction as thus performed causes neither wound nor hernia of the iris. The vitreous humor has never come out in the author's experience.

"His armamentarium is a Beer or Wenzel knife, a Daviel curette, fine forcepts, two pairs of Daviel scissors. Pellier's elevator is used only when the upper eyelid is too big or is raised with difficulty."[10]

C. Sperino[11] describes his usual method of operating as follows: First, a semilunar cut in the cornea, second, incision of the capsule. The author in twenty cases dispensed with the incision of the capsule, removing the cataract by superior keratotomy, and by external manipulation, as Christiaen had done twelve years before.

Lucca[12] describes his operation as follows:—Section of the cornea having been made according to the rules governing the inferior semilunar incision, one introduces through the corneal opening a quite small, ordinary probe, curved and flattened at its extremity, or a cataract needle with a blunt point, which is slipped carefully from below upward between the iris and the capsule as far as the furrow between the iris and the lower part of Petit's canal, holding it always close to the capsule so as not to disturb the posterior surface of the eye.

The instrument is then withdrawn about a line, and the end is moved parallel to the circumference of the crystalline lens, exerting light pressure.

---

[10]Christiaen. De l'extraction simultanée du cristallin et de la capsule. *Ann. d'ocul.* 1845, XIII, pp. 181 to 184.

[11]Sperino. Di una semplificazione dell 'operazione della cataratta per estrazione. *Gior. d'oftal. Ital.*, 1858, I, 186-195.

[12]Lucca. Nuovo metodo per l'estrazione della cataratta capsulare e della capsulo-lenticulare. *Rendi. dell' Accad. med.-chir. di Napoli*, 1866, XX, p. 8.

By this movement one destroys the very delicate mesh of the hyaloid membrane and the crystalline lens may then be removed in its entirety, either by contraction of the extrinsic muscles of the eye or by methodical pressure, or by assisting the extraction, when necessary, by means of Daviel's curette.

Pagenstecher's Operations.

But the most important contribution to the literature of intracapsular extraction up to this time was a paper by Alexander Pagenstecher[13] in 1866. In 1871 his brother Hermann added one still more important.

In these papers they so fully covered the indications and contraindications for the operation, and the technical details of its execution, as they were understood and accepted at that time by his brother and himself, that they are interesting reading even in our day, when intracapsular extraction is receiving more attention than at any time in the history of cataract operations.

Of A. Pagenstecher's paper J. Soelberg Wells[14] says:

"This operation was first practised by Richter and Beer, but fell into disuse until it was some years ago reintroduced, amongst others by Sperino, Pagenstecher and Wecker. Dr. Pagenstecher originally removed the lens and its capsule with much success by the lower flap operation. After practising the extraction of the lens in its capsule for a period of five years, Dr. Pagenstecher has arrived at the following conclusions as to the cases in which it is indicated:

"1. He prefers the extraction of the lens in its capsule to that with laceration of the latter, in all those cases in which it may be presumed that the capsule is firmer than its attachment with the zonula of Zinn. This generally occurs in cases of over-ripe cataract, both in those which are hard and somewhat shrunken, and those which are softish or partly fluid (Morgagnian cataract).

"2. It is also suitable in those cases in which the progress of the cataract is extremely slow, and certain portions of the lens always remain transparent, so that the cataract never becomes perfectly mature. Such cataracts are generally small in size, and the capsule is but very slightly attached to the zonula.

"3. It will, as a rule, be found suitable in those cases of cataract which have become developed after irido-choroiditis and iritis with posterior circular synechiæ. The adhesion between the capsule and the iris must of course be detached prior to the extraction of the cataract, for which purpose a small blunt-pointed silver hook is to be employed.

"4. It may be recommended where, together with the cataract, there is a tremulous iris; for it will often be found that the latter is caused by a shrinking in the size of the lens, or a diminution of the vitreous humor, which should generally lead us to suspect atrophy of the zonula. The last two categories are, moreover, also suitable for this mode of operation because of the tendency to inflammatory complications of the iris which exists in them; in consequence of which it is a matter of much importance to guard the iris against the irritation produced by remnants of cortical substance or portions of capsule."

The following extracts from Hermann Pagenstecher's papers further show the gradual growth of his technique:

"A late and rare indication may be encountered in cases, where during the operation, whether during incision or iridectomy, in a word, before

[13]Pagenstecher and Saemisch. *Klinische Beobachtungen aus der Augenheilanstalt zu Wiesbaden*, Vol. 3, 1866.

[14]Wells. *A Treatise of Diseases of the Eye.* 2nd Ed., 1870.

opening the capsule, there occurs discharge of the vitreous humor. For these reasons, in every operation for cataract, even when we intend to open the capsule, we are always ready to use the curette.

"Like the indications the rules for operation have undergone important modifications in the course of the last few years. We now use the following method:—in place of the flap which we formerly cut we make a superior linear incision and at the same time a large iridectomy.

"In rare cases, when the globe of the eye is well fixed and turned down, it happens immediately after this operation, that a light pressure on the inferior corneal border brings the lens enclosed in its capsule into view and permits its extraction.

"The extraction of the crystalline lens within its capsule removes all predisposition to an inflammatory process on the part of the iris. In the 200 cases on which we have operated, we have not observed a single primary iritis.

"This operation excludes all secondary operations.

"The acuteness of vision is greater after this operation than after any other. Twelve times out of a hundred the acuteness becomes normal. While it presents all these advantages this operation does not entail more total losses of eyesight than ordinary extraction.

"The defects of this operation consist in the difficulty of operative technic and in reaching an exact diagnosis in certain cases.

"If escape of the vitreous humor is observed it may happen that this substance is included between the edges of the wound and retards healing. This prolapse has never been followed by serious consequences."

In 1877 he wrote,[15] "The Graefe knife being employed the incision is made upward with a right hand for either eye, care being taken to gain a conjunctiva flap. Following this a deep large iridectomy is made to prevent the prolapse of the iris. With a dull hook the operator loosens any posterior adhesions if they should exist. With a spoon, slight pressure is made over the upper scleral wound and counter pressure on the cornea at the same time; with the forceps the eye is rotated downward.

"This latter step is not to be prolonged since rupture of the hyaloid and evacuation of vitreous may follow.

"In case of failure of extraction by these means a flat spoon is used, which is carefully pushed behind the equator of the lens, keeping the same in contact with the posterior capsule until its edge reaches the lower equator of the lens. Then slight pressure is made on the lower equator so that the lower margin of the lens points forward. The spoon is now slightly rotated so the handle of it will make its excursion from the center of the wound toward one of the corners of the wound. The lens is thus pulled upward by throwing the handle of the spoon toward the orbital curve, the result being that the lens makes its excursion toward the cornea.

"Slight pressure is then made on the cornea by an assistant, combined with slight gliding motion upward facilitating the expulsion and diminishing the chances of the rupture of the capsule."

And, still later, in 1888, "to get the real value of the two methods of operating is very difficult. A practical result can only be obtained when the operator has a great number of cases at his disposal.

"Therefore in the past few years I have made it a rule to operate on all favorable binocular cataracts on one eye by one method and on the other eye by the other method. This as a rule harmonizes with the indications which I some time ago have mentioned, as one finds frequently a hypermature cataract next to a recently ripe one in the other eye. With oblique illumination a regular gray or gray-yellow color of the anterior cortical layer, with no sharp border lines, discloses the presence of the older cataract, whereas in a younger cataract the layers of the anterior cortical surface will have sharp outlines. In cases of over-ripe cataracts the zonula has undergone atrophic changes which favor extraction within the capsule, with or without the use of a flat spoon and, since the use of cocaine, in most all cases without the loss of vitreous."

"With the extraction *cum capsula* the incision must not be too small,

[15]H. Pagenstecher. Extraction des grauen Staares in geschlossener Kapsel, Wiesbaden, 1877.

although never larger than one-third of corneal circumference. The best cut edges for a flap is obtained with a double edged knife, and an iridectomy is always in place to avoid prolapsus.

"After the iridectomy follows the replacing of the iridic angles at the corners of the wound. A flat spoon is now very carefully introduced behind, but not past, or at least not much past, the posterior pole of the lens. At this time the assistant presses at the lower part of the cornea with a special constructed glass instrument until the lens appears in the wound. The flat spoon here has more the function of an effective slanting surface on which the lens glides, than that of an instrument for traction purpose."

"If the zonula does not give way the spoon may be pushed a little deeper and with the combined pressure by the assistant on the cornea, the extraction is completed.

"The capsule seldom ruptures if proper selections have been made."[16]

Gioppi[17] reports 117 cases operated on with a Graefe knife. An incision is made in the superior quadrant of the sclera, then he introduces a spoon over the superior margin of the lens (after getting the unlacerated iris out of his way) behind the posterior capsule and removes the lens with the unlacerated capsule. Seven failures are reported out of 117 cases. Specific details are omitted. In about one-fifth of the cases the capsule during extraction ruptures. Patients are never bandaged after being operated on, healing taking place in an unusually quick manner. Reports of vision were not given as most of the patients could not read.

In 1870 and 1871 Cannstadt described the following operation:

"I direct a slightly curved cataract needle with its convex side toward the lens and behind the latter, giving it to the assistant to hold and fix the eye with it.

"2. A corneal flap is then made in the usual manner upward.

"3. I then take charge again of the needle and with considerable pressure on the lens behind, the zonula is forcibly ruptured and the lens within the unruptured capsule landed in the anterior chamber.

"4. Slight pressure on the bulb expels the lens readily and the entire operation is completed."

The writer states he has made five of these operations and every one with good results.[18]

Terson[19] describes his operation as follows:

"If all parts of the lens are hard the Graefe curette is pressed in front of the fixation forceps and, to press the lens into the corneal wound with the other hand, a curved forceps is introduced into the anterior chamber. Should the nucleus be covered with soft cortical masses the forceps is introduced deeper, as far as the lower margin of the pupil, to try and grasp the capsule alone which is as a rule thicker in the center. If perchance we pull

[16]The following, more recent, papers may also be consulted, as dealing with the modern history of this form of cataract extraction: H. Pagenstecher. Ueber Extraction mit und ohne Entfernung der Kapsel. *Arch. für Ophthal.*, 1888, Vol. XXXIV, pp. 143-166. Ueber die Kataraktextraction in geschlossener Kapsel. *Period. Internat. Ophth. Cong.*, 1888, VII, 506-511; also, Praktische Rathschläge zur Staaroperation für angehende Augenärzte. *Klin. Monatsbl. f. Augenh.*, 1894, XXXII, p. 339-352. Würdemann. Expression of Cataract in the Capsule with report of 40 cases. *Jour. Am. Med. Assn.*, Vol. LII, pp. 782-787; also, Expression of Cataract in the capsule. *Ophthalmology*, October, 1909, p. 11.

[17]Gioppi. Second article reviewed in *Annales d'Oculist*, Vol. 34, p. 113, 1871, from *Gior. d'oftalmol Ital.*, No. 2, 1870.

[18]Cannstadt. *Klin. Monatsbl. für Augenh.*, 1871, Vol. 4, pp. 131-134.

[19]Terson. *Révue Med. de Toulouse*, 1871, Vol. 6, p. 76.

out the cataract with the capsule in this manner, without rupturing the latter so much the better.

"To pass a curette back of the lens is dangerous because it favors prolapse of vitreous. This is not a slight accident, as other complications may result, especially detachment of the retina."

Landesberg's[20] extraction within the capsule differed in some respects from the method of Pagenstecher: "His excentric incision gives easy rise to bleeding so I made Graefe's peripheric linear incision with one sweep of the knife, leaving a conjunctival flap. Pagenstecher leaves a scleral bridge which he later cuts with a pair of scissors. To extract the lens *cum capsula* I partly employed the spoon of Pagenstecher and partly Daviel's spoon. In two cases I extracted the lens within the capsule with the iris forceps. I grasped the lens with it, and with slow sideward motions dislocated the lens out of the fossa. The lids were held apart with the speculum."

Borysickiewicz[21] found the Pagenstecher method objectionable on account of the danger of prolapse which he states can hardly be avoided. He describes his method as follows:

"The elevator placed, then a sclero-corneal section 3 millimetres wide, made with a Graefe knife, is followed by iridectomy; after this a sharp and flexible iris hook, with a point 1½ mm. in length is pushed flatly between the capsule of the lens and Descemet's membrane downward to the lower pupillary margin where it is turned carefully, to enable a quick and deep insertion into the lens substance. After this had been done, the lens, impaled on the hook, can be extracted direct. A sudden insertion of the hook into the substance of the nucleus causes the entire lens to turn in such a manner that the lower margin is pushed backward, while the upper margin moves forward. By this manipulation in almost every case, a rupture of the zonula at these two spots occurs and makes possible extraction of the cataractous lens in the capsule."

In 1882 MacNamara[22] wrote that "having practised this operation constantly since 1864, I am convinced that if it were possible in every case in which we operate to remove the lens in its capsule without damaging the other important structures of the eye we should have reached perfection in the extraction of cataract."

Wright,[23] in the 1900 edition of his text book, says:

"For convenience we imagine a transverse horizontal line one-third the way down from the upper edge of the cornea. A medium sized Graefe knife is used in making the incision. The point of entrance must be near the sclero-corneal border but entirely within the cornea on the imaginery line as is shown in the dotted line in the figure.

The cutting edge of the knife is directed upward and forward, the plane of the knife making an angle of about 45° with the plane of the normal iris, as is shown in the figure.

The line a-b represents the plane of the normal iris, c-d the plane of the knife.

The back of the knife must be kept on the imaginary line and the counter-puncture made near the sclero-corneal border. The knife is now steadily and gently pushed forward until the section is completed. The line of the incision will now present the appearance of the curved line in the cut.

The patient is now allowed to rest a moment when, if the pupil has

---

[20]Landesberg. Berichte über 123 Staar Operationen. *Arch. für Ophth.*, Vol. XXIV, 1878, p. 59.

[21]Borysickiewicz. Beiträge zur Extraction des grauen Staares der Erwachsenen. *Klin. Monatsbl für Augenh.*, Vol. 18, pp. 199-230, 1880.

[22]McNamara. *A Manual of Diseases of the Eye*, p. 425.

[23]Wright. See, also, An Improved Operation for the Extraction of Cataract. *Columbus (Ohio) Medical Journal*, October, 1884.

not dilated well the iridectomy is made. On the other hand,—as has been indicated—if the pupil had been fully dilated before the incision was made, the iridectomy is to be omitted.

The next step in the operation as usually practiced, whether an iridectomy has been made or not, is to rupture the capsule of the lens, but I am fully satisfied that as a rule the lens is easily removed within its capsule, especially so in this particular operation.

"It is in the experience of all that operate for cataract there would be very few cases of iritis as a result of these operations were it not for the portion of lenticular and capsule which is allowed to remain, and which is frequently impossible to remove, because of the danger of losing vitreous.

"We will then, without rupturing the capsule, take the next step in the operation, which is to press down the upper segment of the cornea with the finger. At the same time, if the lens does not readily present, slight pressure with the finger of the other hand may be made near the sclero-corneal border below. The lens will now present itself and pass through the opening."

Andrew[24] has described the following operation which was performed under an anesthetic:

"Through an upper section with iridectomy, no speculum being used, the lens is detached with a piece of stiff wire one inch in length mounted on a

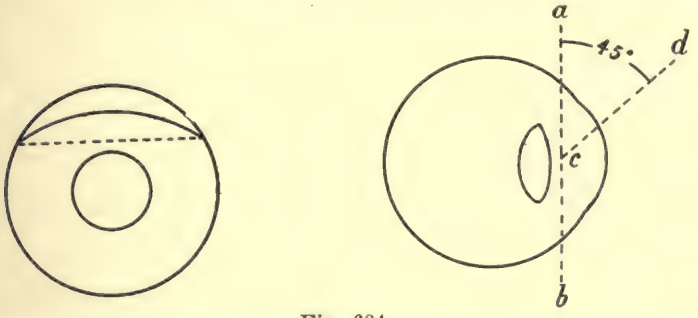


Fig. 624.

Wright's Method of Cataract Extraction in the Unruptured Capsule. *a*, *b*, *c*, line of puncture and counter-puncture of the Section; *d*, Corneal Section.

handle having a point smooth and rounded, and a line to a line and a half of its extremity bent at a right angle. An instrument has been formed to be used in the following manner.

"Either before or after the section a minute opening is made in the cornea close to the margin by a small bent broad needle. The instrument is passed into the anterior chamber sidewise over the lens and under the iris until it reaches its margin. The point is now turned downward and the ligament appears with ease. Following the edge as a guide it may be torn to any extent that the operator may desire. If after the section the instrument is introduced through any part of the opening found most convenient and whichever course it follows being under the iris, that structure is scarcely touched. The endeavor is to tear the ligament without the slightest injury to the vitreous body, and to accomplish this in the manner above mentioned the bent portion is of different length in order to adapt it to an arched or flat cataract. The lens, on slight pressure by a tortoise-shell curette, may be gently eased through this one opening without the aid of any extraction instrument."

---

[24]Andrew. On the Extraction of Senile Cataract in its Capsule. *Brit. Med. Jour.*, 1883, Vol. I, pp. 41-44.

Roosa,[25] of New York, has described an intracapsular operation which he performed with some success, and which had a few imitators,[26] as follows:

"The dislocation of the lens is effected by turning the back of the knife two or three times on the surface of the iris and the lens after the corneal incision is made and before the section is finished. The lens is then made to escape by pressure either with the rubber spoon or the fingers and one spoon. Usually it escapes readily. It is important that the corneal section be large. No iridectomy is performed and no instrument enters the eye after the section is made."

Higgins,[27] speaking of the treatment of immature nuclear cataract says:

"I remove the lens in its capsule through a small flat section made downwards. The instrument employed for its extraction is the small vectis designed by Bell Taylor. The loss of even a considerable amount of vitreous does not of necessity preclude a fairly successful result. In five out of six cases vitreous was lost. I am of the opinion that loss of vitreous does not materially affect the ultimate result of an extraction, provided the whole cataract is brought away."

D. Basso devised an instrument which he called a *reclinateur* (see Illustration) which fitted over the anterior surface of the lens under the iris. He states that slight pressure with it is usually sufficient to dislocate the cataract, which is then delivered in the usual way.

Gayet,[28] in a report on intracapsular extraction, says:

L. Webster Fox[29] has devised a corelysis instrument, a modification of Streatfeild's. He has further modified this instrument, which is reversible, one end for the right and the other for the left eye. Later on he left off the sharp tooth and changed the instrument from a zonulatome to a reclinateur which, barring its slightly larger size, is the same as the corelysis instrument.

He has also described the following operation in certain cases: "Passing the Jaeger cystotome into the anterior chamber and hooking the lens at its inferior margin I make a backward pass, at the same time pressing the upper lip of the incision very gently downward and backward. This tilts the upper part of the lens forward. The lens is then brought back into its normal position and this is followed by rotation on its axis, by hooking the cystotome into the capsule. Then

---

[25]Roosa. Remarks on the Extraction of the Crystalline Lens in its Capsule. *Trans. Am. Ophth. Soc.*, 1885, p. 27.

[26]Bonner. The Roosa Operation. *Trans. Ohio State Med. Assoc.*, May, 1909.

[27]Higgins. On Extraction of Immature Cataract. *The Lancet*, Vol. I, 1888, p. 915.

"Extraction should at present be performed without removing the capsule of the lens. Attempts to remove the lens together with the capsule aim at a legitimate, ideal result."

[28]Gayet. Rapport sur l'opération de la Cataracte. *Bericht d. VII Intern. Ophthal. Congress*, Heidelberg, Aug. 8-11, 1888.

[29]Fox. Delivery of the Lens for Extraction of Cataract. *Jour. Am. Med. Assoc.*, June 4-7, 1907.

removing the cystotome and by counter pressure on the lower third of the cornea with a tortoise shell spatula I express the cataract through the incision without loss of vitreous."

G. C. Savage[30] invented a "cataract-in-the-capsule detacher."

With the exception of the curve in the shank to fit the anterior face of the lens, and the fact that it is made in three different sizes, a careful examination has failed to show me any special difference between it and Fox's corelysis instrument. In principle it is a *reclinateur,* the same as Fox's, Gradenigo's or Basso's.

I have seen Savage perform the above described operation, and I am sure he is complicating intra-capsular extraction rather than simplifying it by this method. His instrument is not new in principle or method of use.

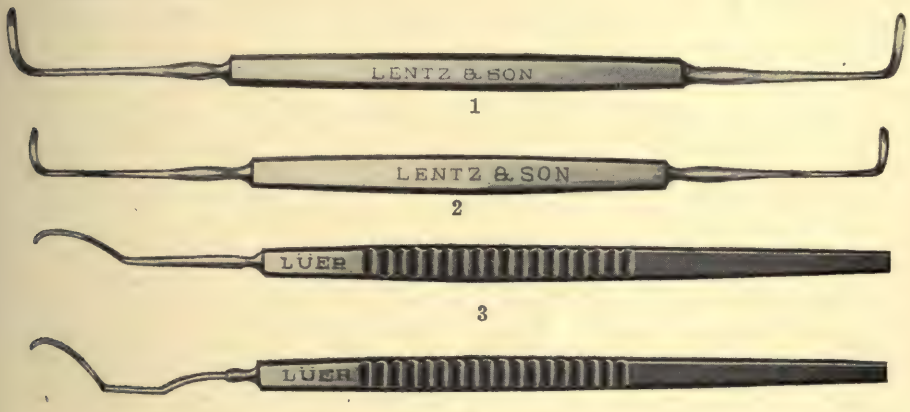


Fig. 625.

Instruments Used in Intracapsular Extraction. 1, Fox's *Detacher;* 2, Savage's *Detacher;* 3, Gradenigo's *Zonulatome;* 4, Basso's *Reclinateur.*

Pagenstecher[31] quite recently recommended a slight modification in the use of the curette or spoon as follows:

"After an incision of one-third of the corneal circumference and an iridectomy *the Pagenstecher spoon* [italics mine] is pressed on the scleral lip of the wound and carried over the edge of the lens into the posterior chamber, but never beyond the posterior pole of the lens. Then, by pressure on the lower part of the cornea with a glass rod, the lens is dislocated upward onto the spoon, which acts purely as a gliding surface and never as an instrument of traction."

This is exactly the way Henry Smith uses a spatula, but not a spoon. While the credit for first using a curette or spoon as an inclined plane may belong to Pagenstecher, it is difficult to understand how a concave spoon with more or less sharp edges could be made to

[30] Savage. *Jour. Am. Med. Assoc.,* 1910. See, also, Guilford's chapter.
[31] Pagenstecher. *Trans. Internat. Ophthal. Cong. Naples,* April, 1909.

serve as an inclined plane without rupturing the capsule in a large percentage of cases. Pagenstecher has not until lately used the spoon, as Smith says he has been using a spatula for years. Smith visited Wiesbaden in 1903, and I dare say was influenced by what he saw and heard there, and it cannot be supposed that he did not influence the Pagenstecher operation in turn. Smith has avoided passing a spatula into the eye behind the lens with the idea of using it as a *traction instrument* to deliver a cataract. On the contrary he has held the spatula behind the section perpendicularly to the cornea resting its back against or just inside the scleral flap. With this support behind the rim of the lens, which has been tilted forward by pressure below, the lens can be delivered in the unopened capsule with great uniformity.

Gradenigo[32] has given much attention to this operation and he has had a number of followers. Among the latter are Ovio[33] and Saggini.[34] Gradenigo believes that the corneal incision must be large, involving a half or even more of the cornea, thus making a very large flap, as in the early days of cataract extraction. He recommends that the apex of the flap should not coincide with the vertical diameter of the cornea, but should be placed somewhat obliquely between the insertions of the superior and external recti.

The surgeon now introduces a *special zonulotome* a millimetre beyond the lower visible edge of the iris (the pupil being dilated with atropine), so as to be secure from the risk of wounding the lens, and turns it on to the zonula, holding the instrument very lightly. If there should be any appreciable resistance felt, the surgeon must withdraw the zonulotome, and introduce it afresh. With great care he lacerates the interior part of the zonula, when the lens may be seen to start forwards and upwards. Then he gradually divides the rest of the zonula, as far as possible, after which, by gentle pressure of the spoon, taking care not to rupture the hyaloid membrane, the surgeon expresses the lens.

To encourage speedy healing, Gradenigo covers the surface of the cornea in the region of the flap by a fold of conjunctiva.

Cassiani[35] has somewhat modified Gradenigo's operation. This consists in laceration of the lower half of the zonula by means of a kind of cystotome, a small blunt hook which is slipped along the equator of the crystalline lens below.

---

[32]Gradenigo. Sull'estrazione capsulo-lenticolare. *Annali di Ottalm.*, 1895. Also, Estrazione della cataratta capsulo-lenticolare. *Ann. di Ottalm.*, 1902, Vol. 31, p. 702.

[33]Ovio. Sullo Mechinesimo del'Estrazione capsulo-lenticolare. *Annali di Ottalm.* Vol. XXVIII, p. 86.

[34]Saggini. Nouveau procéde d'extraction capsulo-lenticulaire du Prof. Gradenigo. *Ann. d'Oculist*, CXXII, p. 344, 1899.

[35]Cassiani. Dell'estrazione capsulo-lenticolare della cataratta. *Annali di Ottalmol.*, Vol. 6, 1897, p. 460.

Of 188 extractions there were only three failures. Ideal results were obtained in 129 cases, good results in 48 cases, fair results in 8 cases.

EAST INDIAN METHODS OF CAPSULO-LENTICULAR EXTRACTION.

The Mulroney Operation.

From the foregoing brief review of the literature of the subject it will be noted that the operations of Pagenstecher and his followers are the only really important ones; and they as a matter of fact continued to be the only methods worthy of serious consideration until certain East Indian surgeons began the practice of removing cataract in its capsule as a routine performance. The enormous material at their command enables them to speak with authority on the subject and it is to them and their pupils that we must chiefly look for additional light on a most important subject.

The Indian Medical Service officers stationed in large cities like Jullundur, Delhi, Agra, Cawnpore, Lucknow, Simla and Benares are expert operators, as I personally know. Many of them can count their cataract operations by the hundred and, if they have been long in the service, by the thousand.

In the hospitals of the great cities, Calcutta, Bombay, Madras and Lahore, in the order named, have lately been stationed Colonel Maynard, Lieut.-Col. Herbert, Major Elliott and Colonel Peters, four of the most noted operators by the capsulotomy method in all India, yet with a denser population surrounding them none of their clinics has kept pace with Smith's in the number of cataract (in-the-capsule) operations performed each year.

The ignorant natives who know nothing about any particular method of extraction leave their homes and pass through these large cities and journey to far off Jullundur, a smaller city than any I have named and more inaccessible to the greater part of India, to be operated on by Smith.

The conclusion seems reasonable that afflicted natives who have flocked to Major Smith's Jullundur Hospital for several years past *knew why they wished to go there.* The word has gone forth, and has been passed from mouth to mouth in true Oriental fashion, that good and lasting vision may be obtained there. Among an ignorant and superstitious people one bad result in a village or town would be known to all the people, and would dampen their ardor for visiting the clinic where it occurred, while even a few bad results occurring in any given section would destroy for a long time the favor in which the operation is held.

Lieut. Col. Mulroney, of the Indian Medical Service, then stationed

at Amritsar, Punjab, was the first surgeon who began as a routine procedure to extract all kinds of cataracts in the capsule by external manipulation after a method largely his own. So far as I can learn Mulroney has not written a line upon the subject of his operation for publication. Fortunately one of his assistants, the late Mecher Chaud Rai Behagur described the operation fully in a paper which he read at Calcutta. This paper is the most important one written on the subject of intra-capsular extraction since Pagenstecher's contributions in 1866, 1871 and later. He thus describes the principal steps in the operation:

"The incision is made by introducing the point of the linear knife into the corneo-scleral juction on the outer side of the globe, on a level with the lower margin of the undilated pupil, the counter-opening being made a little lower on the inner side, and then the incision is completed in the usual way through the cornea. Pressure is now applied with a flat scoop, or a strabismus-hook at the upper border of the cornea, till the edge of the lens presents itself into incision, and then counter-pressure is applied by a curette below the incision; by this process the iris, which is often in the way, recedes, and the lens gradually projects, and when nearly half of it is out of the wound, the pressure is withdrawn and the speculum removed. After this the pressure with the thumb is re-applied to the globe through the upper lid and counter-pressure applied to the ball of the eye below the wound on the sclerotic coat, with a scoop; the pressure is very gently and carefully regulated, till two-thirds of the lens comes out of the wound. Pressure is now again removed, and the patient is directed to close the eye, and look towards his feet, when in most of the cases the lens slips out, and the iris contracts, the edges of the wound become adjusted, and escape of vitreous prevented. In cases where expulsion of the lens is retarded, it is completed by the aid of a scoop or a pair of iris forceps.

"In those cases where the soft cortical substance of the lens comes out, but a hard nucleus remains behind, the capsule is very liable to rupture, unless tact and patience are exercised, till the nucleus also protrudes.

"About 3,400 operations have been performed by this method in the Civil Hospital, Amritsar, of which nearly one-third were performed by myself."

Mercher Chaud,[36] in describing the operation, incidentally mentions the *strabismus hook* for delivery of the lens but probably preferred the Daviel spoon, as he mentions it first.

A later description of the steps of the Mulroney operation is by Senior Assistant Surgeon Hari Chaud[37] who by a peculiar coincidence was Mulroney's last assistant and became Smith's first assistant December 1st, 1909. He thus reviews this operation:

"The incision includes just less than half the circumference, the Graefe's knife is entered in the sclero-cornea and the counter-puncture is also in the sclero-cornea. The incision which is an upper one is made with a single sweep, finishing in the cornea near its periphery; no iridectomy is done. The patient is now asked *to look toward his feet* [the italics the author's] and pressure is made on the sclerotic above the wound with a curette; the lens is thus dislocated at the wound. As soon as the edge of the lens has made its appearance in the wound through the pupil, the speculum is removed. The assistant then retracts the lower eyelid with his thumb on the

[36] Mercher Chaud. A new Operation for Cataract, at the Civil Hospital at Amritsar, India. *Trans. Indian Med. Cong.*, Calcutta, 1894.

[37] Hari Chaud. Mulroney's Operation. *Oph. Record*, July, 1910.

face and with the fingers of his other hand draws back the brow and upper eyelid. The operator again asks the patient to look toward his feet and applies pressure on the lower part of the cornea with a curette and with another curette in another hand he makes counter-pressure above the wound till the lens comes out. When the lens is out the assistant releases the eyelids and the operator draws up the upper eyelids by catching the eye lashes with his fingers and adjusts the iris."

The Smith Operation.

From Mulroney's clinic in Amritsar to Jullundur City is only 52 English miles, and Smith, while making the regular operation, saw many cataract cases which had been operated on at Mulroney's clinic. The results were so satisfactory and so much in harmony with his own experience that he determined in 1895 to follow some form of intracapsular extraction as a routine proceeding. But no method he then knew of was satisfactory because of the position and size of the section, because of the position in which the eye was held and because of the want of control of the upper lid. For these and other reasons the percentage of *loss of vitreous was almost prohibitive;* and the insufficiency of the instruments employed and the technical details adopted in the delivery of the lens were not satisfactory. Smith accordingly developed his own methods which he has finally brought to such a state of perfection.[38]

The Smith operation may be considered the type of the modern intra-capsular operation, as it is also the latest candidate for favor. If nothing else can be said in its behalf the fact that it is the result of the experience of an operator unequaled in point of number of operations performed in the world today, should entitle it to a respectful hearing.

The Jullundur District and Hospital to which Major Henry Smith was assigned some years ago is a general surgical hospital, but during March and April before the hot season, and during September, October and November, as the hot season is passing away and cold weather has not come on, the hospital is filled with cataract patients so that there is room only for general surgical emergency cases. The bulk of the general surgical work is performed at other times of the year. It is the weather which determines the operating season in India. Before Smith's time Jullundur had no greater reputation as an operating eye hospital than many others of the smaller cities of India, but Smith began to do his intra-capsular operation, and in a few years the work

[38]The following list comprises Smith's chief contributions to the literature of the subject: Extraction of Cataract in the Capsule, *Indian Med. Gazette*, July, 1900. Extraction of Cataract in the Capsule, *British Med. Journ.*, January, 1903, p. 719. Extraction of Cataract in the Capsule, *Indian Med. Gazette*, Vol. XL., p. 327. Extraction of Cataract in the Capsule, *Arch. of Ophthal.*, Vol. 31, p. 601, 1905. Extraction of Cataract in the Capsule, *Indian Med. Gazette*, Vol. XLI, p. 121, 1906. Extraction of Cataract in the Capsule, *Indian Med. Gazette*, Vol. XLI, p. 347, 1906. Extraction of Cataract in the Capsule, *Indian Med. Gazette*, Vol. XLII, No. 2, Feb., 1907. Extraction of Cataract in the Capsule, *Ophthalmic Record*, Vol. XIX, No. 2, Feb., 1910.

so far outgrew the small hospital of 48 beds, that it, with the compound (enclosed court) often held several hundred cases. This overcrowding finally became so great that a new hospital was a necessity. Major Smith built a new hospital, costing about 100,000 rupees, collecting the money from well-to-do natives, and without government help, and two days after it was opened (in October, 1909), 127 operations of all kinds were performed in one day by Smith and his assistant.

Vail[39] has published statistics showing the different kinds of cataract cases which presented themselves on a single morning at the hospital for cataract operation. These were:

Mature cataract	48
Immature cataract	23
Hypermature cataract	18
Couched, dislocated	3
Capsular cataract	2
Black cataract	2
Juvenile or congenital	2
Other cataracts	2
	100

Gibney[40] states that "cataracts form fully one-third of the operations performed in India."

During the Fall of 1909, most of which I spent at Jullundur, about 1,200 extractions in the capsule were done by Smith himself, Diwan Ali, his native assistant, Clark, of Columbus, Vail, of Cincinnati, and myself. Many of these operations, other than my own, I witnessed and followed through the after-treatment.

Smith usually reaches the hospital about 10:30 a. m., and, taking his place in the main door of the operating room personally examines each patient. With so many cataract patients (from all over India) the examinations are necessarily brief, but they cover all that is essential. If the patient has a loss of vision not otherwise explained, sufficient to cause him to seek relief, if the pupillary reflex is good, the conjunctiva in fair condition, and the lachrymal apparatus free from disease, the operating-room clerk sends him to the north end

[39]Vail. Cataract Extraction in the Capsule, The Jullundur Patient. *Ophthal. Record*, Feb., 1910.
Smith's Cataract Operation. Impressions Gleaned from a Recent Visit to Jullundur Smith's Clinic. *Ophthalmoscope*, Vol. VIII, No. 6, June, 1910
The Unmodified Smith Operation, *Trans. Am. Acad. of Oph. and Oto-Laryn.* Sept., 1910.
[40]Gibney. Extraction of Cataract in the Capsule, *vs.* the Ordinary Capsule Laceration Method. *Indian Med. Gazette*, Vol. XLI, p. 319.

of the large operating room with other cataract patients, and they squat on the floor in Oriental fashion to await their turn.

The Jullundur staff consists of a native male and an English female assistant physician and surgeon, with seven native helpers, an operating-room clerk, an office clerk, one book and record keeper in the office, and four so-called dressers. He has for this large hospital about the amount of help required to run an operating room of a modern hospital in one of our large cities.

I have seen the new hospital crowded beyond its capacity with eye patients alone; yet it has 500 beds.

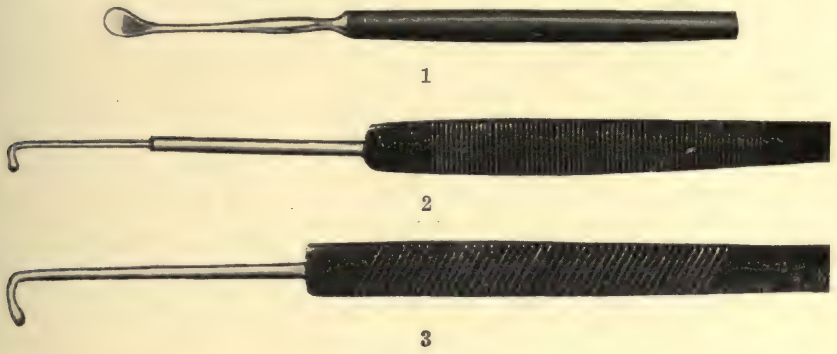


Fig. 626.

Intracapsular Extraction. Smith's Original Instruments About Twenty Years Old. 1, Curette or Spoon; 2, Delivery Hook; 3, Lid Hook.

Of Smith's earliest operation of fourteen years ago little remains save the original principles on which it was based. The section has been changed from his early one (a slightly modified Lebrun) to the incision described by Mackenzie. The instruments employed have been modified and the manipulation with the expression hook and the spatula, and the direction of the pressure on the cornea and lens, have also undergone change.

In the operating room the three tables faced a large window on the west. This position is of great importance to Mohammedan patients, who in their five daily prayers and other acts of worship always face toward Mecca. The Hindus are densely ignorant and deeply religious, and the attitude of worship (folded hands and eyes turned upward), is as natural to them as to breathe; and the same is true of Mohammedans. Many of them seem to pass into an auto-hypnotic state while being prepared for operation. If not spoken to or aroused they will go through an operation without a motion or a murmur, but if spoken to (as in directing them to look up or down) the spell is broken and they are not such good patients afterward.

Fortunately their usual attitude Smith has found to be the best for easy and smooth delivery of the lens with a minimum loss of vitreous. It is the position the eyes naturally take in the relaxation of sleep, or under the influence of an anesthetic; it may, therefore, be called the position of rest in which muscular compression of the globe is practically nil.

Technique of the Smith Operation.

The patient is prepared by the instillation of two drops of a 5 per cent solution of cocaine, five minutes apart. The eyelids are washed with soap and hot water, a small silver speculum, with a weak spring and without a set-screw, being in position, the outer one-third of the eye lashes is clipped off as closely as possible, so that the knife in making the corneal section cannot possibly touch the lashes. If at any time an instrument intended to enter the eye touches anything other than the eye-ball, it is immediately sent to the sterilizer. Then the eyelids are lifted straight away from the globe by raising the speculum. The assistant now flushes the whole conjunctival sac with the one to two thousand bichloride solution held in a five-gallon glass container sus-

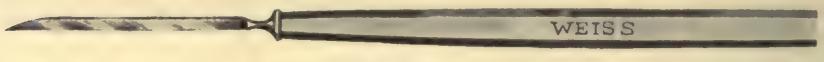


Fig. 627.

Intracapsular Extraction. Modified Graefe Knife, with straight cutting edge.

pended from the ceiling. The flushing is done thoroughly and about four ounces of the solution is used as a rule, but if the condition of the conjunctiva requires it, more is used. This is left in the conjunctival sac for a short time, and then drawn off by turning the head of the patient to one side and making slight pressure at the outer angle with the thumb.

The hands of the operator are washed with soap and hot water before beginning the day's work. After that all washing of the hands is with the bichloride solution.

The rather severe antisepsis of the ocular field seems necessary since seventy-five per cent. of the cataract cases which came to operation at Jullundur had trachoma in some of its late stages, according to Smith's estimate. Many of the eyes I saw operated on with no other preparation than washing the side of the face and eyelids and the bichloride flushing above referred to, would be refused operation without preparatory treatment at any eye hospital in America with which I am acquainted. Notwithstanding the scant preparatory treatment, I saw only five cases of post-operative infection in about 1,200 operations, and only a small percentage of iritis and iridocyclitis, a record

remarkable among a people who are dirty and filthy to a degree seldom seen in this country. While I do not use bichloride solution as a rule in operations at home, I am satisfied from my experience and from that of several Indian Medical Service officers with whom I discussed the subject, that for the diseased and germ-harboring conjunctival sacs of the natives, 1 to 2,000 bichloride solution freely used inhibits the development of germs and secures immunity from post-op-

Fig. 628.

Instruments Employed by Smith in His Operation for Intracapsular Extraction. 1, Speculum; 2, Lid Hook; 3, Expression (delivery) Hook; 4, Double-ended Spatula; 5, Broad Forceps for Extraction of Ruptured Capsule.

erative infection which could not be secured in any other way. It seems to be more important that it should be used liberally rather than that the strength should be increased above 1 to 2,000. This solution,

which would be badly borne by normal conjunctivas in America, seems not painful to the diseased conjunctiva of East Indians.

If Herbert's explanation of the action of bichloride is correct it can do no harm, and it should be used generally in India and *elsewhere whenevr there is a suspicion that the conjunctiva is not normal.* We would do well in this country to profit by Indian experience in the use of bichloride. I think if careful attention were given to the lachrymal apparatus and strong bichloride solutions used in every extraction, *infections would be even more rare than they now are.*

Fig. 629.
Intracapsular Extraction. Smith's Toilette.

The instruments are carefully and thoroughly sterilized.

Smith thus describes the steps of his own operation:

"Children and juveniles alone are not admissible because it is almost impossible to dislocate their lenses. The eye being prepared (atropine is not necessary) and the spring speculum inserted, the eye is fixed with special forceps, the Graefe's knife is inserted in the sclero-cornea and makes its counter-puncture in the sclero-cornea of the opposite side; the incision is half or nearly half the circumference of the sclero-cornea. The knife is driven through to the heel, the handle being lowered as it goes through so as to elevate the point to avoid the nose or eyelid. It is used after it makes the counter-puncture to cut as it goes through. If it is a new knife and in good order, the incision should be completed with this thrust. If not com-

pleted a single draw-back should complete it without any sawing. We have thus an ideally clean cut wound. This incision I finish in the cornea and make with a sweep so that the edges of the corneal wound will be cut as nearly as possible at a right angle to the surface and not be obliquely sliced, which latter facilitates over-riding and which is the cause of a good deal of unnecessary astigmatism. An iridectomy may or may not be done according to the fancy of the operator, but my advice to a beginner is to do an iridectomy. There is probably a little more liability to incarceration of the iris in this operation than in the capsulotomy operation and incarcerations are more liable to occur where there has been escape of vitreous than where there has not; hence, I advise beginners to do an iridectomy. Incarcerations of the iris in this operation have a distinct connection with meddlesome dressing and meddlesome inspection. These cases, without some special indication, should not be dressed or inspected *earlier than the expiration of eight clear days or even ten clear days from the time of operation* when no further dressing will be required."

"In this operation the novice owes most of his failures and most of his difficulties to not making a sufficiently large wound, and wherein his wound fails most is that it lacks in depth towards the sclerotic. Capsules bursting are very largely due to this cause.

"When the incision is finished and the iridectomy performed (if the operator decides to do one) the speculum is removed, and the operator proceeds without speaking to the patient. In the case of an immature lens or of a hard cataract, with a spatula in the operator's left hand ready for use if required, he proceeds to press back with the point of a strabismus hook

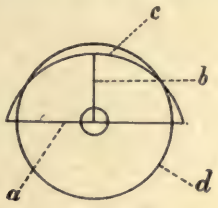


Fig. 630.

Cataract Extraction in the Unruptured Capsule. Smith Section. The Relations of, *a*, the Base Line; of the, *c*, Average Section (14 mm.) to the, *b*, Height of the Incision (5 mm.) and the Corneal Diameter (12 mm.); *d*, Limbus Corneæ.

towards the optic nerve, the point of the hook being placed over the lower third of the cornea. The pressure is steady and the point of the hook should not be moved until the upper edge of the lens tilts forwards and is thus seen to be dislocated, having been made to swing round on its transverse axis. The moment the lens is seen to be dislocated, the pressure through the point of the hook is gradually turned more and more towards the wound, pressure being maintained all the time so as to keep the lens up to the sclerotic margin, the pressure with the hook becoming gradually lighter and lighter and the hook gradually sliding after the lens until the cornea is folded beneath it. At this stage it is delivered. In a low tension eye the beginner should follow up the lens with the spatula in addition to the hook, as with it he can maintain a sufficient tension in the eye and thus allow his right hand instrument to follow up the lens more lightly. In rare cases of low tension eyes he might find it advantageous when the lens is half way out to apply a little counter-pressure above the wound with the spatula. In the case of intumescent lenses and Morgagnian cataract (in which the nucleus is small and is surrounded by a considerable amount of soft disintegrated lens matter) the capsule is generally extremely delicate and if dislocated in the manner above described, is liable to burst when the lens is half way out, allowing the nucleus to escape and to be itself retracted with considerable amount of lens matter. The operator is then placed in a difficult position, the capsule being dislocated at the wound. To overcome this I observed that lenses of this class occasionally turn a half somersault,

dislocating opposite the wound, and that having done so, the capsule very seldom burst and when it did burst it was attached only in the neighborhood of the wound and was not drawn back, and that under these conditions it was very easily caught with a pair of dissecting forceps and removed entire without inserting any instrument into the eye. I proceeded to imitate this accident with this class of cataracts, first by applying pressure over the ciliary region, but soon desisted as I had a few cases of expulsive hemorrhage from choroidal detachment, which I attributed to my manipulation of this region. I then commenced to press with the point of the strabismus hook sufficiently deep over the lower border of the lens. I then found I could almost invariably make these lenses dislocate below and then turn a half somersault. This pressure and traction are always over the zonule.

"As soon as the lens turns up into the wound, showing that it is freely dislocated below, the operator should cease to make traction toward the patient's feet but make direct pressure backwards, then backwards and upwards and, finally, more and more towards the wound folding the cornea beneath the lens until it falls on the outside of the cornea. At this stage the capsule has not been dislocated from the zonula in the neighborhood of the wound. The hollow of the curve of the strabismus hook should now be made to sweep along between the lens and the wound to complete the detachment. The beginner, while using the hook thus, would do well in all instances to put the spatula on the cornea so as to keep up sufficient tension in the eye and so prevent the lens from slipping back into the eye in this later stage whether it be of hard or of soft consistency, since a lens is occasionally liable in this late stage to slip back into the eye and then to be exceedingly difficult to remove.

"The hypermature cataract is, of all cataracts the most difficult to dislocate. It has become shrunken, its capsule thickened, and its attachments have become firmer than is the case with any other senile cataract. The operator in this case should proceed with the strabismus hook as in the case of immature and hard cataract. The spatula in his left hand should be in position at the margin of the wound to drop behind the lens the instant the edge of it is seen at the wound, as otherwise pressure on the cornea will only squeeze out vitreous, the lens refusing to move. It should be dropped almost straight down into the eye, the back of it being kept throughout against the sclerotic margin of the wound. The lens should be pressed against it with the hook from the outside and thus made to slide up along the inclined plane of the spatula. The spatula should be kept steady in position, care being taken to not use it as a means of lifting out the lens. If used to lift out the lens, the capsule is very liable to be ruptured and vitreous escape behind it at the same time. It does not require to be inserted behind the lens to more than a trifling distance; it is thus used to prevent the pressure from the hook on the outside from putting objectionable pressure on the vitreous. The spatula for this purpose should have a slight curve and be about 7/16 inch broad and not sharp anywhere, so as to avoid the risk of injury to the capsule. A dextrous operator, if he follows these directions and the patient being fairly well behaved, will be able to extract hypermature cataracts thus with escape of vitreous in a trifling percentage of cases. I believe that hypermature cataract is infinitely more common in India than in America or Europe, as in those countries patients have their cataracts extracted before they reach this advanced stage.

"There is one other variety of cataract worthy of mention. It is a rare form, the color of coarse white soap, a characteristic color when once seen. It is exceedingly difficult to dislocate and when recognized the operator should proceed as in the case of hypermature cataract."

Reposition of the Iris in the Smith Operation.

"The iris being a sticky membrane, is found, after the lens is extracted in capsule, sticking to the sclerotic and in the angles of the wound. Whether an iridectomy has been done or not its careful reposition in this operation is of the utmost importance. The assistant firmly holding up the eyelids and brow as before, it will be observed that the cornea drops back and that the iris, not in the neighborhood of the wound, falls on the vitreous leaving

the aqueous chamber and the space which the lens occupied vacant. With a suitable repositor the operator should release the remaining parts of the iris from the sclerotic and from the angles of the wound. When this is properly done the operator is able to see back to the very base of the iris all round in the neighborhood of the wound. There need be no hurry about the reposition of the iris. It can and should be done with the utmost care. If this is done and the eye carefully dressed and not redressed until after the eighth day, and the patient behaves sensibly, iris prolapse will seldom be seen. Complications of the iris in the wound are generally due to not replacing it properly and to meddlesome dressings and meddlesome inspections and foolish conduct on part of the patient.

"If vitreous escapes it should be snipped off with scissors and not left hanging in the wound where it will act as a drain, preventing union. As

Fig. 631.
Clark's Speculum.

iritis, iridocylitis and sepsis are so exceedingly rare following this operation, the after treatment is almost nil. Atropine is not necessary."

Arnold Knapp, after a visit to Major Smith's clinic in Jullundur in 1906 practically confirmed Smith's statistics. In "2,616 operations he had 6.8 per cent. loss of vitreous, and 0.3 per cent. of iritis in 2,494 operations when the lens came away whole. When the capsule was opened intentionally or was ruptured in delivery, iritis was observed in five per cent. of the cases." I myself am able to confirm the substantial accuracy of those statistics, and point to Ring's collected

Fig. 632.
Large and Small Extraction Hooks.

statistics of 1,032 operations by the usual methods that furnished 7.32 per cent. vitreous loss, 4.32 prolapse and 13.15 iritis.

The Instruments Employed in the Intracapsular Operation.

The *speculum* is a small silver instrument with a spring only sufficiently strong to hold the eyelids apart. It readily yields to the pressure of the lids if the patient "squeezes," as it is not supplied with a stop, or set, screw. The parts intended to receive the margin of the lids are deeper than in the ordinary speculum, which is a great advantage, as this admits of lifting

the lids away from the eyeball when necessary. It seems to be practically the Clark speculum.

The two (so-called) *strabismus hooks* are also made of silver; the larger, called the *lid hook,* is used for elevating and drawing out the lower lid. It resembles a very large strabismus hook and is original with Smith; at least I have found no reference to it elsewhere. This hook, 5 inches long, because of its small bearing surface, *bends the lid to an angle* which breaks the power of the orbicularis, and prevents

Fig. 633.
Double Spatula for Intracapsular Extraction.

the patient from squeezing the lids together. My assistant Millette, prefers a square handle, and the hook in line with one of its corners. Smith's hook is far superior to any other lid elevator for the purpose for which it was intended.

The *expression hook,* of silver, brass or iron, is much smaller than the lid hook. It should have a smooth bulbous tip, so that on contact with the cornea it will not abrade the epipthelial layer. A nickel-plated instrument is unfit for this purpose; it slips too easily

Fig. 634.
Capsule Forceps.

on the cornea. The distance from the bulbous tip to the shank of the instrument I have had made shorter than the original because, first, it is easier to manipulate on the lower border of the cornea in expressing the lens and, second, if it is necessary to use it in drawing the lens out of the incision it is less in the way (in working under the lid) than the longer tip.

The *double-ended spatula* should also be made of silver, and five

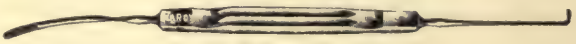


Fig. 635.
Iris Repositor for the Intracapsular Operation.

inches long, of which two and one-half are handle. It terminates in two flat ends, 6x12 mm. It has no close resemblance to a scoop or spoon and is not intended to be used as such, but rather as a *gliding plane for delivery of the lens* under certain conditions.

A *medium sized, anatomic forceps* completes the list of *original Smith instruments.* It has a broad, blunt tip, 1/8 to 3/16 of an inch wide, so that if the capsule ruptures it can be extracted in the majority

of cases by pressing lightly on the upper or posterior lip of the section, and the other tip can be used on the lower or anterior lip of the section to coax the capsule out into the section where it may be caught and extracted. This is especially true if the lens has turned over and a portion of the capsule is hanging out of the wound. In fact, this is one of the advantages of turning the cataract over.

The *iris repositor* is a modification of the Knapp instrument, the probe end of which is bent at a right angle 2 mm. from its tip.

I make some claim for suggesting recent modifications in this repositor.

Fig. 636.

Intracapsular Extraction. Greene's Modification of Knapp's Iris Repositor.

The *fixation forceps* has 3 or 4 teeth to each blade and is of the mouse-toothed variety. This insures a firm hold on and good control of the eyeball, without tearing the conjunctiva. If the eye is small and deeply set, it will be possible to lift with such forceps the globe from the depths of the socket so that in finishing the section the point of the knife can be directed over the bridge of the nose without engaging it or the lids.

A new *Graefe knife,* 30 millimetres or even less in length, will answer in the hands of an expert, but for the average operator, a longer and wider blade has many advantages. Such a blade should not be less than 32 millimetres in length and a trifle less than 3 mm. wide.

Fig. 637.
Cataract Knife.

It ought to have the well known bayonet point, or a straight cutting edge, and a *cimitar point* made entirely from the back. I have had some credit for devising this shape of blade, but I find that it is much older than I thought.

Thompson, of Indianapolis, showed a knife of the same general design at the 1910 meeting of the American Medical Association which he has used for eighteen years. Ziegler, of Philadelphia, has also used practically the same knife, which he purchased in Paris many years ago.

The Author's Method of Intracapsular Extraction.

The *assistant,* a most important factor in the operation, should

take his place on the left side of the patient for either eye. If he prefers he may sit down. He should take the large Smith lid hook between his thumb and index finger and insert it under the upper eyelid and make gentle traction upwards in the orbital axis; the patient lying on his back. When this has been done he should drop his middle, ring, and index finger on the patient's supra-orbital ridge and push directly away from himself; that is, towards the top of the patient's head. His elbow should be elevated so that there will be room for the surgeon to use his *left* hand and arm—as will be later explained.

The duties of the assistant require a thorough knowledge of the

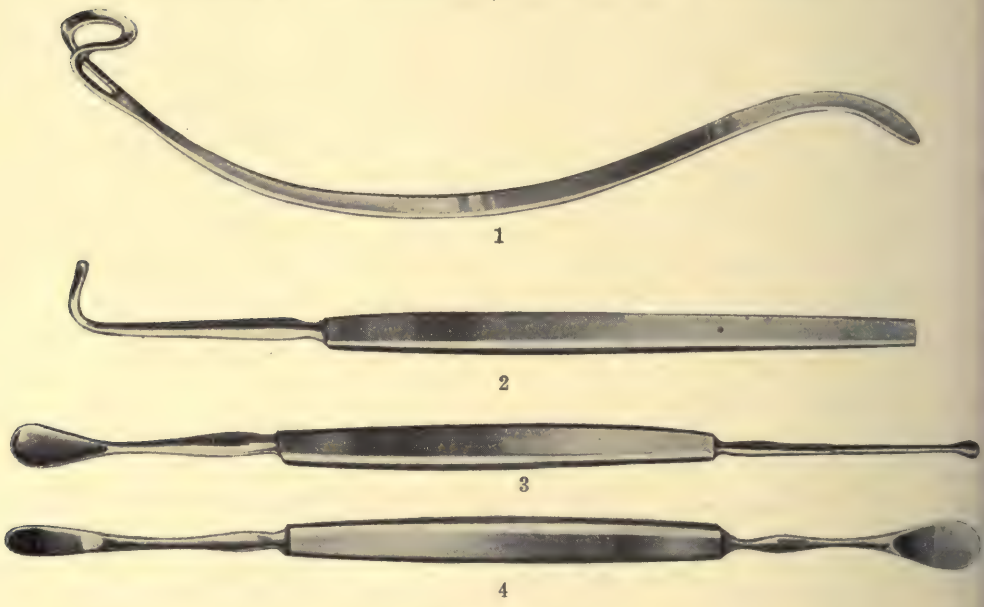


Fig. 638.

Instruments Employed in Author's Intracapsular Extraction. 1, Fisher's Lid Elevator; 2, Millette's Modification of Smith's Lid Hook; 3, 4, Greene's Modifications of Smith's Spatula.

principles and technic of the operation, as well as of the accidents that may happen during its performance. A good assistant is not made in a day, nor in many days. He should take off all pressure from the eyeball, and expose as much of the field of operation as may be necessary for the manipulations of the surgeon. If a speculum is introduced he has nothing to do until the section and iridectomy are made. If, as the author prefers, the Fisher lid elevator is used, when the section and iridectomy are made, the assistant elevates the upper

lid with it, and draws down the lower lid with (a piece of gauze under) his left thumb.

Before leaving this subject I desire again to call attention to the perfect control the assistant has over the orbicularis muscle with the large Smith hook under the upper lid.

In intra-capsular extraction there are a number of details which should be carefully studied and worked out by the prospective operator. The *section* should always be ample, the *iridectomy* of medium size, and the manipulations, particularly the *pressure-manipulation*, should never be excessive or prolonged, and never made over the *center* of the cornea.

I make it a rule to explain and make clear to every patient that three things are required of him during the operation. First, he must look straight ahead, or possibly a little upward, during the section and iridectomy; second, he should look as high up as he can, *without effort*, during the extraction of the cataract and making the toilette, and third, he must under no circumstances look down after the operation is over, and the eye has been bandaged. Indeed, these directions might be sim-

Fig. 639.
Scissors for the Intracapsular Operation.

plified by directing the patient to direct his gaze straight at the ceiling, and continue to keep it fixed in that or the corresponding direction, until he is placed in bed.

This is the most important assistance the patient can give the operator. I believe that the patient's looking quickly and forcibly down, in spite of explicit directions to continue his gaze directly upwards or towards the superior margin of the orbit, has been responsible for more than a third of my cases of vitreous loss after the delivery of the lens. Assuming, however, that one has a skilled assistant, trained to watch the progress of the operation, and able to anticipate and meet emergencies, escape of vitreous need not take place in more than three per cent. of all cases.

When everything is ready for the extraction of the lens, the operator should take his place on the proper side of the patient for either eye, standing far enough down along his side so that by stooping or, if he prefers, sitting, he may always have a good view *under* the upper lid and see the whole length of the section—whose behavior is the best guide the operator can have as to how the lens will present and be delivered.

The Section in Capsulo-Lenticular Extraction.

The idiom, *"la section, c'est l'opération,"* generally applied to other forms of extraction, is equally true of expression in the capsule.

As has been stated, the lens in its capsule cannot be delivered without a large section. To make the Jullundur section properly the knife should be held in the right hand when operating on either

Fig. 640.

Intracapsular Extraction. Smith Method with Fisher Lid Elevator. Corneal Incision. (Greene.)

eye, point directed toward the center of the pupil, and entered at an angle of about 20 degrees above the horizontal plane. With the knife held at this angle the point will cross the chamber and not pick up the iris, as is likely to happen if the blade passes across with its edge parallel to the iris. For making the section of the right eye the op-

erator should stand behind and a little to the right of the patient. For the left eye he should stand a little to the left and rather in front of the patient. The end of the handle of the knife should touch the third phalanx of the index finger, but should be so lightly held far out on the handle that the end can drop into the space between the base of this finger and the thumb. In this space it can be manipulated and rotated between the fingers and thumb with a freedom not possible

Fig. 641.
Intracapsular Extraction. Jullundur Corneal Section.

by the ordinary method. The little finger rests on the patient's temple to steady the hand of the operator, so that the section can be made by the finger and wrist motion.

The puncture and counter-puncture should be made as far back in the angle as "anatomy and experience teach us to go, without wounding important structures"; about 1½ mm. is a fair average. The knife should cross the chamber with its back level with the center of the undilated pupil.

The chief fault of the large section is that it is likely to lack in depth at the inner angle where in my judgment, it should be as deep as at the outer angle. With a curved sweep upward the knife should emerge in the cornea from 2 to 3 mm. from the limbus, and at a right angle to its surface. This will give a shoulder to the section intended to prevent over-riding of the flaps and a high degree of astigmatism.

It will be observed that this section is almost entirely corneal and has all the advantages and disadvantages of a section so located. One

Fig. 642.
Intracapsular Extraction. The Iridectomy. (Greene.)

of the chief advantages is that in a 12-millimetre cornea it gives plenty of room for the largest lens to pass through. Another, and perhaps the most important advantage is that it is located just right to receive the emerging lens as it is tilted forward in delivery. Its greatest disadvantage is that it is placed so far away from the nutritive supply of the cornea. It resembles somewhat the Lebrun section, but is more nearly a *Liebreich made upward, not downward.*

The *average American cornea* I have found in 600 old soldiers to measure about 11¾ mm. in its horizontal diameter, and the average

cataract in the capsule to measure about 8¾ mm. I judge from these facts that both the puncture and counter-puncture should be at least one millimetre outside of the cornea so that the base line of the section should measure about 14 mm., which will coincide with the greatest horizontal diameter of the cornea. For any cataract of the usual size, the section should have the dimensions given above, and if the cornea measures less than 9½ millimetres in its horizontal

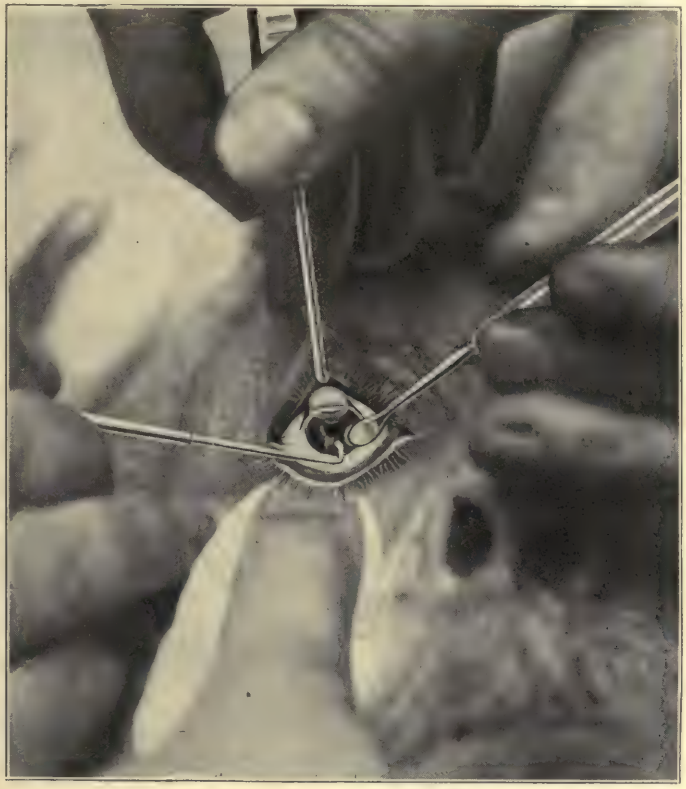


Fig. 643.
Intracapsular Extraction. Smith Method. Straight Delivery of The Lens.

diameter, the operation is contraindicated, because the diameter of the lens and that of the cornea too nearly coincide and the lens could not be delivered without exerting dangerous pressure on the eyeball.

With every plane of the section parallel to every other plane close coaptation of the lips of the wound and prompt healing should be the rule. There should be no "stair-steps," or "saw-teeth" in the section such as are observed when the knife is made to saw through the cornea by to-and-fro motions.

I have not from the beginning been entirely satisfied with the Jullundur section either in India or at home in persons over seventy years of age. Something of course depends on their physical condition. Some persons are physically older at seventy than others at eighty. I have gradually returned to the circular marginal section for this class of cases which I used before going to India. Admitting the advantages of the favorable location of the Jullundur section for easy delivery of the cataract, and admitting that cystoid healing does

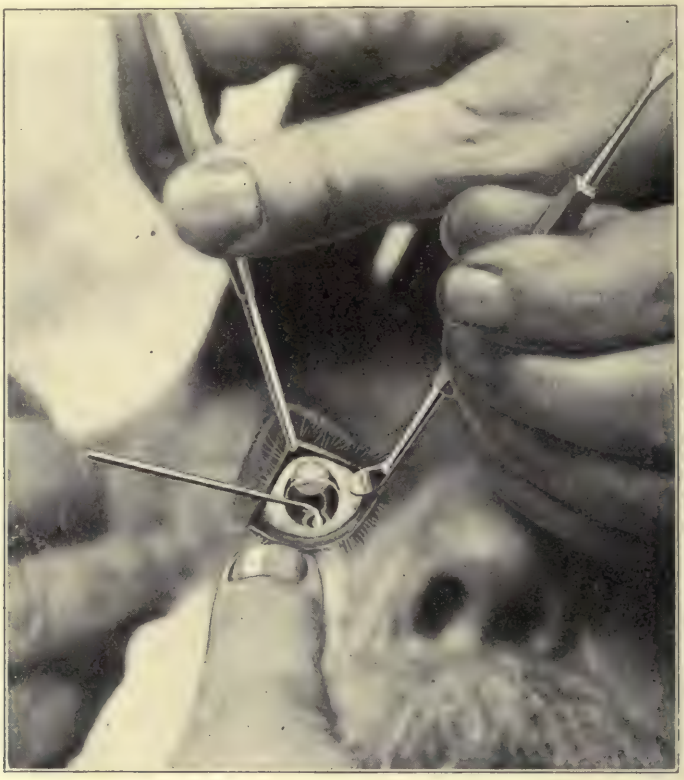


Fig. 644.

Intracapsular Extraction. Smith Method. "Tumbler" Delivery of The Lens.

not occur in a pure corneal section and accepting the statement of those who contend that the over-hanging ledge of cornea in the posterior lip of the section is a protection against vitreous loss— *admitting these great advantages*—we must not forget that as an incision is made lower in the cornea we take it away from the nutritive circulation at the limbus, and it is a question to what extent the low section may influence the healing by its location. We also know that for some rea-

sons all low corneal sections have heretofore been short-lived, e. g., the Liebreich and the Lebrun.

Fig. 645.

Intracapsular Extraction. Modifications of Corneal Incision and Toilette. (Greene.)

The *circular marginal section,* which I advise in patients around and above 70 years of age, is practically the same as the original Daviel section. It should, however, involve only one-half of the cornea. It should be made upward and should lie in the limbus, where nutrition is better than out in the cornea. Among modern incisions the nearest approach to it is Santerelli's; or perhaps an enlarged de Wecker would give a better idea of its size and location. See the chapter on the Extraction of Senile Cataract.

I have observed that my most frequent troubles after operation with this section relate to the healing of the wound, and incidentally to conditions which ought not occur if the nutritive material for closing the section were promptly furnished. Old people do not seem able to furnish this with uniformity. My statistics show that in using this section (before going to India), I had fewer cases of delayed healing and lower degrees of astigmatism. I have come to the conclusion that the disadvantages of the large Jullundur incision are, first, its location in the cornea seems to delay healing in very old people, as just stated. Second, it seems because of its size not to heal so firmly and solidly in a given number of days as the regular incision. Third, having apparently healed, it will sometimes reopen either from intraocular pressure or from external injury. I have also seen it occur several times from straining at stool. Fourth, I have seen the section remain open for five weeks before closing solidly. These, also, are the cases so likely to be complicated by prolapse or incarceration of iris, kerato-iritis, and high degrees of astigmatism. Trouble is likely to follow if a cataract section does not close within twenty-four hours. This is not likely to occur when the section is clean cut, and the flaps are closely coapted. Epithelial layer should be united with epithelial. Bowman's membrane with Bowman's membrane, *substantia propria* with *substantia propria,* etc. Such perfect primary union was the rule at Jullundur, but in my American experience of the operation about 5 per cent. of patients around seventy years of age do not have this primary union. I have observed delayed closure of the section in the eye wards of the Hospital of the National Military Home where the average age of the soldiers of the Civil War was on June 30th, 1910, 69.65 years. The oldest was 97, the youngest 60.5 years; and these figures are based on 6,084 inmates.

This in brief is the section which McKechnie[41] has so fully described and was made in practically every operation at Jullundur. I have made the same section many times and found that it healed firmly

[41]McKechnie. On Incision of the Eye with Special Reference to Incision for the Extraction of Cataract, and for the Relief of Glaucoma. *Archives of Ophthal.*, Vol. XXXVIII, 1909, pp. 228-253.

in 183 of my Indian 354 cases on the fifth day. In America, for some reason it has not been so satisfactory and I have been led to search for an explanation in racial characteristics and the fact that the age of American cataract patients is greater than those operated on in India. I am not unmindful of the fact that I may not make the section now as well as under Smith's direction, but we should remember that our patients average about twenty years more than the East Indian's.

Hirschberg[42] has shown that the average age of cataract patients in India is forty years; in Germany sixty-two years. Vail[43] has estimated the average age of our patients at Jullundur at fifty-six years. Jackson, of Denver, has given the statistics of 1,545 persons over 50 years of age, patients in Wills' Eye Hospital, Philadelphia; 439, or 27.8 per cent., had some degree of lens opacity. Arranged in five-year periods, the per cent. showing such opacities was as follows: 15 per cent. between 50 and 55, 16.1 per cent. between 55 and 60, 30.2 per cent. between 60 and 65, and 77 per cent. between 65 and 75. Norris has given statistics of 584 inmates of the poorhouse, between 50 and 60 years of age, in whom 264, or 45 per cent., had traces of cataract.

The Iridectomy in Capsulo-Lenticular Extraction.

The Jullundur method is as follows: One blade of the iris forceps held in the left hand was laid on the posterior lip of the wound and the other on the anterior lip of the wound, and by pressure downwards (more on the anterior than the posterior lip) the iris was made to prolapse, was caught as the forceps closed, and cut in the direction of the section by the scissors in the right hand. An advantage of such an iridectomy is that no instrument enters the anterior chamber.

While in Jullundur I was permitted, at my request, to make the iridectomy as I had made it for many years, viz.: by passing the points of the forceps well inside the section (if necessary) and catching a small bit of iris and drawing it out and cutting it off from below upward. By pressing the scissors downward across the section a more *peripheral* (the important thing) iridectomy can be made.

I believe that *any* cataract operation will be safer if the iridectomy is performed from two to four weeks (or longer) before the extraction. I have proved this contention to my own satisfaction in making a test of the value of a small preliminary iridectomy with the incision back in the limbus in 100 cases.

There is in intra-capsular extraction a tendency to drawing up of the pupil which I am convinced would be best counteracted by a

---

[42] Hirschberg. Arch. für Augenheilk., 1909, p. 189.
[43] Vail. *Ophthal. Record*, Feb., 1910.

preliminary operation; otherwise *by a small iridectomy made as peripheral as possible* at the time of the corneal section.

Expression of the Cataractous Lens.

Assuming that the right eye is to be operated on and that the section and iridectomy have been made as just related, the surgeon, after telling the patient to continue looking up as high as he can, should pass his left hand (in which he holds the double-ended spatula) beneath the assistant's right hand and arm and hold it perpendicular to the cornea, close to its lower border. The smaller hook the surgeon will lay flat on the sclero-corneal junction below, resting the third and fourth finger on the patient's temple. Its point should overlap the cornea about 3 mm. A little pressure and the hook is given a quick, sharp turn so that the point bears directly backwards on the lower rim of the lens towards the optic nerve.

If these manipulations do not dislocate the lens, the hook should be laid flat across the sclero-corneal junction below, as stated before, the point directed upwards towards the pupil, and pressure should be

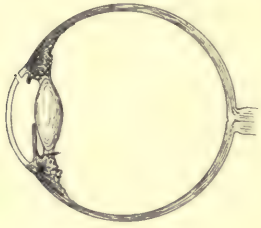


Fig. 646.

Straight Delivery of the Lens in its Capsule. Section and iridectomy completed. Lens not disturbed.

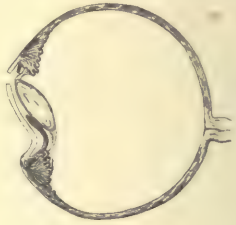


Fig. 647.

Straight Delivery of the Lens in its Capsule. Tension put on the zonula below through the cornea and iris, with the point of the delivery hook, for dislocating the lens. Note the direction of this pressure backward toward the optic nerve.

made directly backward with the side of the curved portion of the hook. This manœuvre is intended to serve a double purpose, to dislocate with the point and put tension on the vitreous with the curved part of the shank.

A better way, when the cataract does not dislocate easily, is to make light pressure with one end of the spatula on the cornea at the limbus, or on the sclerotic. The object of this manipulation is to *put tension on the vitreous,* to help dislocate the cataract and crowd its upper border into the incision. When the lens stands upright, it is dislocated and the pressure with the spatula must instantly cease. The pressure with the point of the delivery hook must now be *quickly*

changed upwards, in the direction of the wound. Many avoidable losses of vitreous occur at this stage of the delivery by the *operator not being equal to the emergency* and *continuing the pressure backward too long,* when all that it is required to deliver the lens is to fold the cornea under it with the point of the hook, *making a phimosis, so to speak.*

The position of the cataract has now been changed from a horizontal to a perpendicular plane. Seventy-one per cent. of the cataracts at Jullundur were delivered in just this way, that is, *came "straight."* While the cataract is not yet outside of the eye in this position, its important connections are broken and a little more tension is put on the vitreous to force it into the section where the cornea can be folded under it, or the curved part of the same hook can be slipped under the equator and by slight traction the lens can be rolled edgewise through the section and delivered.

Suppose an intermescent or *any cataract* with *soft cortex and a small nucleus* is to be delivered. The surgeon should place the de-

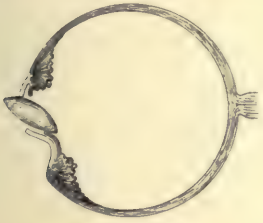


Fig. 648.

Straight Delivery of the Lens in its Capsule. Position of the lens in the section after the zonula has given way from the pressure, as shown in the foregoing figure. The pressure is now up, towards the wound.

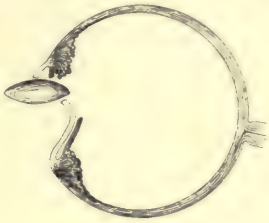


Fig. 649.

Straight Delivery of the Lens in its Capsule. Lens Entirely Dislocated. It now Stands Perpendicular to the section, which is the best possible evidence that it is dislocated, Delivery being aided by folding the Cornea under it, with very little pressure upward.

livery hook in about the same position as that described above but instead of pressing directly backward toward the optic nerve, the instrument lying flat, he should twist or turn the hook between his fingers until the bent portion stands perpendicular to the cornea, and then give it a further twist or turn until the point catches under the ciliary ridge (body). This, of course, requires some pressure, but as the point catches the operator will know it. He must continue to make *light, steady pressure,* not backwards, as in the former case, but directly downwards towards the patient's feet, away from the wound. The section will gape, the zonula will give way below, and the intra-ocular tension will force the lower border of the lens forward, and it will *turn over.*

These manipulations must be made slowly and with the utmost gentleness, otherwise vitreous may be lost, or the capsule will rupture. In either event it is possible to catch it with forceps and draw it out if the operator is dextrous. Vitreous is seldom lost when the lens is delivered in this way.

Turn-Over Delivery of the Lens.

Twenty-nine per cent. of cataracts delivered at Jullundur "turned over," the manipulations being deliberately directed to that end.

Consequently, I believe Elschnig[4] to be clearly wrong when he asserts that "the operator is not able to effect one or the other delivery at will."

A marked peculiarity of Indian eyes is collapse or drooping of the anterior corneal flap after the cataract has been delivered. This condition is difficult to explain; it must be a racial peculiarity. My theory is that East Indians carry so little superfluous fat that the usual cushion of adipose tissue behind the eyeball is largely absent, the

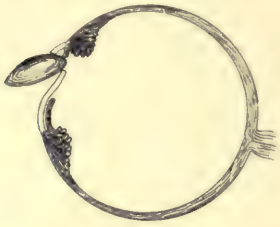


Fig. 650.

Straight Delivery of the Lens in its Capsule. Lens Dislocated and Almost Delivered, by the Cornea being Folded Under it. In this stage of delivery the lens becomes top-heavy and tends to fall forward.

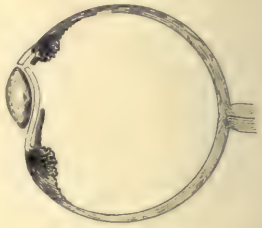


Fig. 651.

Straight Delivery of the Lens in its Capsule. Complete delivery of lens lying on its face with section closed behind it. Lens has been both dislocated and delivered.

eyeball hangs loosely in the orbit and tends to sink backwards and make the section gape.

It is surprising what an amount of traumatism the anterior epithelial layer of the cornea will bear. In my early operations when I dislocated the lens by the old plan of rubbing, or pressure to and fro, over the lower third of the cornea, opacity of that area was quite common, but in an experience of 150 operations with the newer manipulation I never saw an opacity that interfered with vision.

The Jullundur Toilet.

The toilet of eyes operated on at Jullundur was very simple. It consisted in freeing the iris angles of blood and tags of capsule (if ruptured) and smoothing out the pillars with the point of the hook with

[4]Elschnig. Extraction of the Cataract in the Capsule, *Ophthalmology*, Vol. VI, 1910, No. 3.

which the lens had been expressed. The bulbous point was too large to get well down into the angle, so that there were cases of incarceration of iris and dislocation of the pupil which should not have occurred. I am satisfied that better results will follow the use of my *smaller* iris hook and repositor previously described and pictured. By the use of this instrument the iris may be smoothed out of the angles and from the under surface of the posterior lip of the section by gently

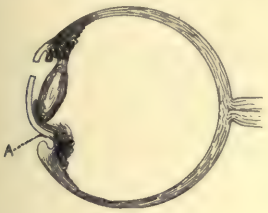


Fig. 652.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Point (*a*), where the tip of the delivery hook is to be applied to make traction on the zonula in the direction of the patient's feet. This frees the lens below. It is still anchored above and the intraocular pressure causes it to swing outwards and turn over.

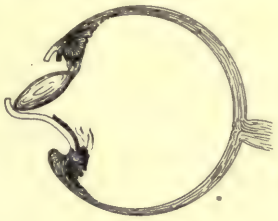


Fig. 653.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Advanced stage of the same manipulation. Note the wide, gaping wound, *somewhat exaggerated in the cut.*

passing the flat end of the repositor, which has been bent to an obtuse angle, between the iris and the under surface of the posterior lip of the section. On elevating the hand the same end will also free the angles;

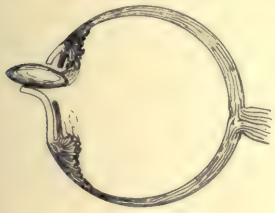


Fig. 654.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Lens passing out through the section still anchored above, the cornea being folded under it with the hook, from the direction of the pressure. The cataract fills the wound. Vitreous is seldom lost at this stage.

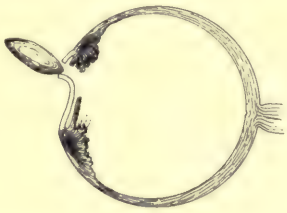


Fig. 655.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. The lens in an advanced stage of birth. It is now beyond the perpendicular meridian but is still held by a few Zonular fibres. The cornea is folded farther under it.

or, better still, the instrument may be reversed and the probe pointed end, which has been bent to a right angle with the shank two mm. from its tip, employed for the same purpose.

The Author's Cataract-in-Capsule Toilet.

The dressing should be made according to the taste of the operator. I prefer a half-round, dry, cotton patch between layers of gauze, laid on the closed lids of each eye. The irregularities are filled out with small pledgets of picked cotton which are held in place by pieces of adhesive straps. I use a flannel bandage for the patients on whom most of my operations have been performed—old soldiers, many of them feeble in mind and body, bad subjects, as a rule, for any operation. Unless the patient complains of pain, or unless there is some other urgent reason for it, the eye should not be inspected for seven full days after this dressing.

Summary.

Finally, my matured belief is that extraction of cataract within the capsule offers the following *advantages*:

1. A cataract can be removed at any stage of development.
2. No discission is ever necessary.
3. There is comparative freedom from post-operative inflammation.

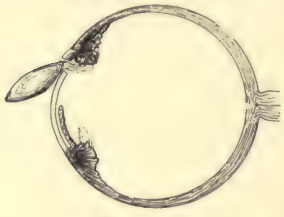


Fig. 656.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Lens free from all attachments and showing a tendency to fall away from the eye.

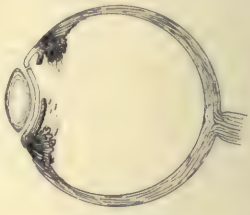


Fig. 657.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. The lens is delivered, the lips of the section have come together and the cataract is lying in the concavity of the cornea.

4. There can be no capsular entanglements in the wound; prompt healing is the rule.
5. The method is especially adapted to institutional work; one operation does all.
6. No ripening methods need be tried.
7. The result is better average vision, which is the end and aim of every cataract operation, and the vision once secured does not deteriorate with time, if the fundus remains healthy.

The *disadvantages* of the method, as I have met them, are the following:

1. The operation is highly technical, and can only be learned at the elbow of an expert, who has plenty of material to demonstrate it. This material is now only available in Smith's clinic at Amritsar.
2. Loss of vitreous is the only serious disadvantage, which, it must be admitted, is slightly greater for the average operator than after the regular method.

3. Traumatism as a rule (to which there are many exceptions) is greater than in the regular operation.
4. From a cosmetic point of view, a wide, updrawn pupil (if it results) mars the appearance of the eye, while it may not cause any diminution of vision.
5. A *skilled* assistant is always necessary in performing this operation.
6. The extremes of age do not furnish varieties of cataracts as suitable for the method as does the middle period of life.
7. In America greater quietude of the patient and slightly more prolonged convalescence than in India is the rule to which, however, there are many exceptions.

It is not my desire to be considered a champion of the Smith, or any other, cataract operation. There is a broader ground on which to stand, viz.: That operation should be selected which seems best suited to the case in hand, rather than to select the case for the operation. Certain types of cataract, I am sure, will show fewer complications and better average visual results when extracted in the capsule than if operated on by regular methods, *and the converse must be true.* But having emphasized the strong point of intracapsule extraction, especially of the Smith method, and having admitted its weak points as I have observed them in about 700 operations, I cannot avoid the conclusion that the Smith operation well deserves a place among cataract operations, and that its technic is a long step towards the ideal operation, which has been the dream of operators from the beginning.

BIBLIOGRAPHY.

In addition to the references already made in this chapter the following are of much interest and value:

Beard. *Ophthalmic Surgery*, 1909, p. 561.

de Schweinitz. *Diseases of the Eye*, 1910, p. 553.

Fox. *A Practical Treatise on Ophthalmology*, 1910, p. 438.

Weeks. *Diseases of the Eye*, 1910, p. 853.

Henry Smith. *The Treatment of Cataract*, 1910.

Elliott. Some Observations on Cataract Extraction, *Indian Med. Gazette*. June, 1908. Operations for Cataract. *Indian Med. Gazette*, XLI, p. 475, 1906. *British Medical Journal*, Dec., 1908.

Herbert. Extraction of Cataract in the Capsule, *Indian Med. Gazette*, Vol. XLI, 1906, p. 51.

Oxley. Visial Results in Forty Consecutive Extractions of the Lens by Smith's Method. *Indian Med. Gazette*, Vol. XLI, p. 482. 1906.

Clark. An Indian Experience in Cataract Extraction. *Ohio State Med. Jour.*, January, 1910. One Hundred and Twenty-one Cases of Extraction of Cataract in the Capsule by the Method of Major Henry Smith, of Jullundur, India. *Arch. of Ophthal.*, Vol. XXIX, No. 1, 1910. The Attitude of the Profession Towards the New Operation for the Extraction of Cataract in the Capsule, the So-called Smith Indian Operation. *Ophthal. Record*, February, 1910, p. 102.

Casey Wood. Ophthalmology, *Pract. Med. Series*, 1910, p. 62. *Jour. A. M. A.*, 1909, p. 777.

Stricker. Nutrition of the Lens in its Relation to Cataract, *Annals of Ophthal.*, Vol. VIII, 1899, pp. 482-487. *Trans. Ohio Med. Society*, May, 1909. A historical Review of the Development of the Cataract Operation. *Jour. of Ophthal. and Oto-Laryngg.*, Oct., 1909.

Ring. *Medical Record*, Feb. 23, 1895, Vol. VII, pp. 234-236.

A. Knapp. A Visit to Major Smith's Clinic at Jullundur, *Arch. of Ophthal.*, Vol. 37, pp. 13-15, 1908.

Maynard. The Combined vs. the Simple Extraction of Cataract, a Study of 2,000 Cases, *Indian Med. Gazette*, Vol. XL, p. 317.

Marple. Extraction of Cataract in the Capsule, Claiborne's *Symposium on Cataract*, 1908, p. 117.

Sattler. Major Smith's Modification of the Modern Cataract Operation, *Ophthal. Record*, Oct., 1909, pp. 496-501. Extraction of Cataract in the Capsule, *Trans. Ohio State Med. Assoc.*, June, 1910.

Cheney. Extraction of Cataract in the Capsule with a Report of ten Cases. *Ophthalmology*, Vol. II, Oct., 1906, p. 1.

Nesfield. Extraction of the Lens in its Capsule by Division of the Suspensory Ligament. *Indian Med. Gazette*, July, 1909.

Lawford. Abstract of Papers on the Smith Operation, read at the Bombay Congress, April, 1910. *Ophthal, Review*, Vol. XXVIII, (337), Nov. 1909.

Birdwood. Extraction of Cataract in its Capsule, Smith's Operation, *Ophthal. Record*. Feb., 1910.

Würdemann. Expression of Cataract in the Capsule, *Trans. Sec. Ophthal. A. M. A.*, June, 1909; also, *Ophthalmology*, Oct., 1909.

Lister. The After-Effects of Escape of Vitreous, *Trans. of the Bombay Med. Congress*, Feb., 1910.

Millette. Observations on Major Smith's Operation for Cataract, *Ohio State Med. Jour.*, April 15, 1910.

CHAPTER X.

DISCISSION, RECLINATION AND MATURATION OF CATARACT WITH SOME OTHER OPERATIONS ON THE CRYSTALLINE LENS.

By PETER A. CALLAN, M. D., New York City.

Needling or Discission of the Lens—Historical Review—Forms of Cataract Amenable to Treatment by Discission—Extraction Instead of Discission in Certain Kinds of Soft Cataract—Fixing an Age Limit in Discission—The Instruments Used in Needling—Position of the Patient During the Operation—Dangers and Complications of Discission—Removal of Cataract by Suction or Aspiration—The Operative Treatment of High Degrees of Myopia—Historical Review—Arguments For and Against the Removal of the Lens in High Degrees of Myopia—Indications for Operations in High Myopia—Contraindications — Statistics— Retinal Detachment Following Myopia Operations—Should One or Both Eyes Be Operated On?—What Operations shall we Choose?—Other Dangers and Complications—Dislocation of the Lens and Operations for its Relief—Complete Displacement or Luxation—Partial Dislocation, or Subluxation—Difficulties and Dangers in Operating on Luxated Lenses—Couching, Depression and Reclination of Cataract—Dangers and Complications—Indications for the Employment of Couching—Technique of the Operation—Willburg's Operation—Anterior Scleronyxis—The Maturation or Artificial Ripening of Cataract—Indications for the Operation—Various Methods for Maturing Unripe Cataract.

NEEDLING OR DISCISSION OF THE LENS.

Historical Review.

The Ancients, doubtless, held erroneous views in regard to cataract, but that they knew no other means than depression for removing the obstructing membrane, is open to question. *Discission was practised,* but, as some claim, only as an aid to depression. The lens was considered the seat of vision, consequently if that were opaque or removed, sight would be lost.

Various erroneous views were held as to what constitutes cataract, namely, an obstructing membrane behind the cornea; a thickened fluid in the anterior chamber or vitreous; or an opaque substance

behind the pupil. These ideas generally prevailed up to the beginning of the seventeenth century, while some surgeons even maintained them for more than a century later. The astronomer, Kepler, was one of the first to demonstrate the fact that the lens focuses the rays of light on the retina and is not the seat of vision. Francois Quarré and Remi Lesnier confirmed this view of the function of the lens about the middle of the seventeenth century. Soon afterwards, Borel, Bonnett, Blégny, Lucas Tozzé, Pollinus Bernard, Rohaut and Gassendi demonstrated that an opacity of the lens constitutes cataract. Notwithstanding all that had been clearly shown in regard to cataract, the views of the Ancients still held sway until the beginning of the eighteenth century, when Maître-Jean, Boerhaave, Méry, Heister and many others again demonstrated that changes in the lens constitute cataract. This opinion found general acceptance about the middle of the same century.

From writings of the Ancients now extant conflicting deductions have been drawn, *pro and con,* as to their knowledge of operative procedures for the removal of cataract.

Depression was almost universally practised for the removal of the obstructing membrane. Many claimed that discission, when done, was merely an aid to depression. Galen,[1] however, recommended discission for the removal of cataract in the case of children.

Pliny[2] wrote in regard to the removal of cataract as follows: *Squamam oculi emmendam potius quam extrahendam, i. e.,* "If the cataract cannot be depressed, then it may be extracted;" but it does not follow that the ancient idea or method of extraction and the modern is the same. Still, it all goes to show that other methods besides depression were known, if not generally practised.

Depression held its own as an almost universal method to the middle of the eighteenth century, when Daviel introduced extraction. Towards the end of the eighteenth and the beginning of the nineteenth century, it was, nevertheless, depression *versus* extraction. Percival Pott, Callisen, Hay and Dupuytren were strong defenders of depression as the better method. In fact, Scarpa abandoned extraction in favor of depression. Baron Wenzel, Richter, Beer, Sir William Adams and Heister, on the other hand, favored extraction.

Middlemore,[3] as late as 1835, wrote as follows: "Wenzel and Sir William Adams have given us a very gloomy and overcharged account of the evils resulting from depression which Scarpa and Samuel Cooper have very keenly ridiculed and ably refuted."

---

[1]Galen. *Lib.* XVI, Cap. 19.
[2]Pliny. *Nat. Hist. Lib. XXIX,* Cap. 1, page 497.
[3]Middlemore. *Treatise on Diseases of the Eye.* London, 1835.

Although practised to some extent by the Ancients as an aid to depression it is, however, to the merit of modern surgeons that the operation of discission has been established on a firm basis and limited to the removal of soft cataracts. Barbette says:[4] *"Licet cataracta non satis intra pupillæ regionem sit depressa, dum modo in particulas sit divisa, perfect viso intra sex aut octo septimanas (sæpissime,) licet toto operatio absque ullo fructa peracta, videatur; quod aliquotus experientia edoctus loquor."*

Banister[5] states: "There are some cataracts which scatter and vanish when the needle is applied to them, because they are not hard and solid to bear the needle, which goeth through them as it would a piece of cheese, whereof, they are commonly called *'cataracta lactea,'* because their colour and substance resembles milk. That the chirurgeon may meet this inconvenience, he must labour to loose it, pressing it with his needle on either side, for by this means, I have seen, and in the end the party hath recovered his sight."

The same fact had been observed by other surgeons, (Read, Maître-Jean) in the early part of the eighteenth century, but it remained for Percival Pott[6] in 1775 to make use of an experience in depression, viz.: that if the capsule of certain cataracts that could not be readily depressed were freely lacerated, they would be absorbed by the action of the aqueous humor. He was the first to lacerate the capsule as a distinct method of removing cataract of the "mixed kind." He did not attempt anything further in the way of depression, but allowed absorption to remove the lens. He says: "I have sometimes, when I found the cataract to be of the 'mixed kind' not attempted depression, but have contented myself with a free laceration of the capsule, and having turned the needle round and round between my finger and thumb, within the body of the crystalline lens, have left all the parts in their natural situation; in which cases, I have hardly ever known them fail of dissolving so entirely as not to leave the smallest vestige of cataract."

Gleize[7] (1796) in attempting depression (owing to a movement of the patient having lacerated the capsule) had to withdraw the needle. He found that the lens had disappeared on the twentieth day. He then used this method subsequently, and found that soft cataracts disappeared.

Conradi[8] had a similar experience except that in extracting a

---

[4]Barbette. *Chirurgia Barbettiana.* Cap. 16, Part 1.
[5]Banister. *A Treatise of 113 Diseases of the Eye.* London, 1622.
[6]Percival Pott. *Chirurgical Works.* Vol. III, page 156.
[7]Gleize. *Nouvelles observations pratiques sur les maladies de l'oeil et leur traitement.* Paris, 1796.
[8]Conradi. *Arnemann's Magazin.* Vol. I S-1, 1797.

lens he had made the corneal section and punctured the capsule with a needle; then was obliged to stop. At the end of eight to twelve weeks, the pupil was clear. He operated by discission on a woman of seventy, but at the end of twenty months, no change had taken place in the lens. From these experiences, he proposed discission through the cornea as a regular procedure. He made an opening in the anterior capsule and finally limited the operation to soft and fluid cataracts.

Buchhorn called the procedure *Keratonyxis.*

Langenbeck,[9] Beer[10] and Jäger, Sr.,[11] tried discission, the first giving the most favorable reports of the method, while the two last were very unsuccessful. There is no evidence to show that any discrimination was made by any of these three surgeons as to the kind of cataracts to which they applied discission.

Scarpa[12] confined the operation to milky soft and cheesy cataracts. His method was to make a very free laceration in the anterior capsule and then to cut up the pulpy mass that remained. Contemporaneous with Gleize, Conradi, Langenbeck, Beer, Jäger and Buchhorn, was Saunders,[13] who believed that he had discovered a new process for curing cataracts in children, namely, discission.

He refers to his procedure for curing cataract in children in a letter to the General Committee of the London Infirmary for Curing Diseases of the Eye, in 1809. In a previous report he stated that he had operated successfully on fourteen persons born blind, one of whom was only two months old. He particularly advocated operating on children when very young, so as to prevent the development of unsteadiness of the eye. His new procedure consisted in freely lacerating the anterior capsule within the area of the pupil and then gently sinking the needle into the body of the lens. This method of operating on children he continued until his death in his thirty-seventh year. He had intended to operate on hard cataracts, but his demise prevented him from following in the foot-steps of all his predecessors and finding failure.

If any one surgeon deserves exceptional mention for the early development of discission, that honor belongs to Pott. Possibly Conradi comes next, as he limited the operation to the anterior capsule. His failure to extract after discission led to the disappearance of an opaque lens. The experience gained in this instance, and a failure of

---

[9]Langenbeck. *Prüfung der Keratonyxis.* Göttingen, 1811.
[10]Beer. *Arnemann's Magazin.* Vol. I, Stuck 3.
[11]Jäger, Sr. de Keratonyxidis usu. *Diss. Inaug.* Vienna, 1812.
[12]Scarpa. Briggs' Translation. London, 1811.
[13]Saunders. *A Treatise on some Principal Points relating to Diseases of the Eye.* Edited by his friend and colleague, J. R. Farre. London, 1816.

discission in aged patients, led him to confine the operation to the young. Saunders comes next in order as he firmly believed he was the first to discover discission for the curing of cataracts in children. He started out right, but he was possessed of the erroneous idea that *all* cataracts would yield to the new process.

Forms of Cataract Amenable to Treatment by Discission.

Lenticular opacities occurring in the young, whether congenital or due to disease or traumatism, are to be considered as *soft cataracts.* It not infrequently happens that congenital cataracts of young persons go slowly on to absorption, so that after a lapse of time, the pupil may be partially clear, or a thickened capsule with little or no lens matter remains.

In passing, it may be pointed out that the traumatic type of cataract disappears much more quickly. The thickened capsule due to cellular proliferation is apt to have calcareous deposits upon it and these prevent a just estimate of how much of the lens remains. This latter class really belongs to the type of *secondary cataract* and cannot be absorbed as a result of needling. These calcareous deposits are frequently the source of trouble, falling at the time of operation or subsequently, into the anterior chamber, where they are slowly absorbed. They act as foreign bodies while undergoing absorption, and at times set up an irido-cyclitis that may end in the loss of the eye.

Extraction Instead of Discission in Certain Forms of Soft Cataract.

If they are of long standing, little or no lens matter remains within the capsule, especially if the cataract be due to accidental traumatism, or to a previous needling. An ordinary discission is of little use in trying to obtain a clear pupil.

The pupil should be fully dilated and a *linear extraction* done in the following manner: The incision in the cornea should be made above, about 2 to 4 mm. from the limbus, large enough to permit the exit of the calcareous mass. A cystotome must then be passed into the anterior chamber and the periphery of the anterior capsule freed from the thickened membrane. The aqueous humor, if it has escaped, must be replaced by a normal salt solution. Then introduce into the anterior chamber a closed duck-bill forceps, which must be opened and one blade pushed behind the mass and the other in front; the calcareous mass is then seized and extracted from the eye.

Another method is to insert a De Wecker's scissors instead of the forceps; cut the thickened tissue in two halves, then remove them by the aid of forceps.

In young subjects the sphincter of the pupil contracts very quickly on the escape of the aqueous humor. In order to avoid the necessity

for an iridectomy, push the calcareous mass downwards until the upper edge shows free of the pupil, when it can be extracted by either of the above methods. When small pieces of the calcareous mass break off in the manipulation, wash them out with a saline solution by means of an irrigator, as described at the end of the section on Artificial Ripening of Cataract.

What is the Age Limit of Discission?

As a rule, until the twenty-fifth year the lens is susceptible of absorption when an opening is made in the anterior capsule, permitting the aqueous humor to come in contact with the lens fibres. The nucleus is not generally hard enough to prevent absorption although frequent exceptions are found below this limit, while, occasionally, the lens is absorbed by discission up to the thirty-fifth year and even later. The density of the cortical layers varies considerably even in young subjects, so that it is always a safe procedure to regard the *first* discission as tentative and not make a large capsular wound, nor to go deeply into the lens substance.

Some surgeons follow von Graefe's precept, viz.:—to make an iridectomy prior to a discission. This, to my mind, is totally unnecessary and inasmuch as discissions are done for the absorption of soft cataracts in young persons, the cosmetic effect ought to be considered and no mutilation done that is not absolutely necessary.

A discission is easy to perform and when carefully done is followed by little, if any, reaction. In the case of infants with congenital cataract, a small capsular opening is quite enough to cause the entire disappearance of the lens in from three to six months. In the type where there is only partial opacity at or about the center of the lens, more than one needling is necessary.

In traumatic cataract, if seen soon after injury, the free use of atropine with ice-cold compresses should first be employed to prevent too rapid swelling of the lens.

From the eighteenth to the twenty-fifth year, the process of absorption is much slower in all forms of cataract and if the surgeon wishes to depend on discission to remove the cataract he should proceed with caution, and thereby avoid complications.

A second needling should be done from six to eight weeks after the first, if the process of absorption has apparently come to a standstill. The inclination of most operators is to hasten matters and consequently do too much. In this regard, possibly the importunities of older patients form an important factor. However, the question of time with children is of little importance; so that there is no excuse for hastening the process by numerous or extensive needlings.

At the same time, the procedure that entails the least risk is the

one that should be chosen in all cases. Possibly an experienced surgeon, who has his patient under full control in a thoroughly equipped eye hospital, with trained assistants, nurses, etc., may take chances and do an extensive laceration of the capsule, but the inexperienced surgeon will be wise if he proceeds more cautiously. In any case, it is not proper to do too much and thereby court disaster, an event which sooner or later is bound to happen even to the most experienced operator.

The Instruments Required for a Discission.

The *instruments* required are an eye speculum, a fixation forceps and a Bowman's needle. The eye speculum and forceps should be put into boiling water for five minutes, the Bowman's needle for a few seconds; then all the instruments should be placed in a shallow tray containing absolute alcohol. Prior to use, they should be washed off in a four per cent. solution of boric acid.

Position of the Patient for Discission.

The patient should be reclining upon an operating table. The surgeon when sitting behind the patient has much better control of the eye below, than in any other position, both as to seeing and operating. Local anesthesia is sufficient except in the very young or unruly, where general anesthesia may be necessary. The pupil of the eye to be operated on should be previously dilated *ad maximum;* the eyelids and eye brows should be made as sterile as possible. Then insert the eye speculum and flush the field of operation freely with a four per cent. boric acid solution. If ordinary daylight is not enough to give a clear view of the cornea, iris and lens, some form of artificial light with a condenser should be used. The surgeon then seizes the globe of the eye below, near the limbus, the eye is rotated downwards and the globe pierced with a Bowman's needle. The point of entrance should be in the upper-inner (left), or upper-outer (right) quadrant of the eye, 2 mm. from the limbus, and in sclero-corneal tissue. The flat of the needle is held parallel to the plane of the iris, the point inserted under the conjunctiva, pushed through the sclera into the anterior chamber, the flat of the blade still carried parallel to the plane of the iris to the lower periphery of the capsule. Then the handle of the needle is raised and the cutting edge turned and brought in contact with the capsule, which should be cut by an upward pull of the needle to about 3 mm., penetrating into the lens fibers about 1 mm. (See the figure).

The needle is then withdrawn in the same manner that it entered the globe. If the shank of the needle is properly made, the point of entrance is so completely filled that no aqueous escapes. Care is to be exercised that the point of the needle does not become entangled in the

iris in passing across the anterior chamber. In either event it is best to postpone operation until another occasion. The eye operated on should be bandaged and the patient put to bed in a darkened room.

Atropine must be used freely (to keep the pupil fully dilated) and continued during the entire period of absorption. If the eye is quiet at the end of the first week, gentle massage of the globe should be done several times daily over the center of the cornea, through the closed eye-lids. This greatly assists the absorption of the cataract. In case of beginning reaction, ice cold compresses should be freely used so as to prevent too free access of blood to the parts.

Dangers and Complications of Discission.

The untoward results liable to follow this operation are: first,

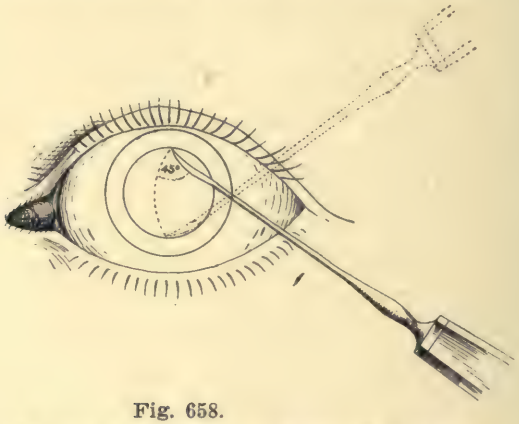


Fig. 658.

Discission of the Left Eye; the Puncture Behind the Limbus. The needle is entered as at *a;* and assumes the position *x*. The handle is now raised to *xx*, the point of the needle following the dotted lines of the diagram.

glaucoma; second, iritis, irido-cyclitis and panophthalmitis; third, infection.

Glaucoma occurs from this cause in two forms, inflammatory and non-inflammatory. Acute inflammatory glaucoma is the most frequent result of a too free discission, due to the irritation of the rapidly swelling lens substance. It comes on usually within the first five days following the operation. If the attack be severe, with neuralgic pains in the head and globe, accompanied by nausea or vomiting, increased tension of the eye ball and a hazy cornea, a linear extraction (q. v.) should be made without delay, thus permitting the evacuation of the swollen opaque lens substance. This operation will dissipate all signs of inflammation, providing the operation is done at the onset of the symptoms.

A non-inflammatory or chronic form that may occur months or even years after operation, is due to the contraction and thickening of capsular bands that pull on the ciliary process. Cutting these bands so as to end the traction, stops the process, and this is best done with scissors. I have seen six such cases where iridectomy proved of no avail and relief was only obtained by severing these capsule fibers.

Iritis may occur; likewise, irido-cyclitis may result from too rapid swelling of the lens substance. These sequelæ are best treated by leeches to the temple, the free use of atropin and hot (from 120° to 130° F.) comprsses, continuously applied to the closed eye-lids of the affected eye.

These conditions when severe are difficult to diagnosticate from the signs and symptoms due to infection, especially when the process results in *panophthalmitis*. It is, indeed, a question as to what role

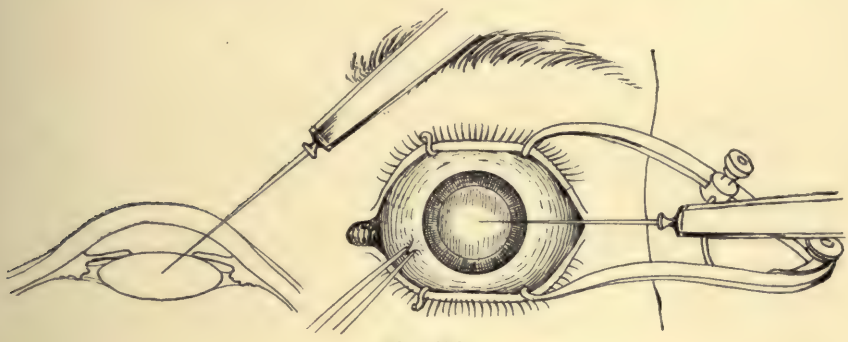


Fig. 659.

Discission Through the Clear Cornea.

The needle is directed forwards to a point about I mm. from the centre of the dilated pupil, pushed about a mm. into the lenticular substance and then a cut 2 mm. long is made through the central area of the lens.

infection plays in post operative uveitis; it is possible that germs may be introduced at the time of the operation.

Needling Through the Clear Cornea.

Some operators prefer to make the puncture, especially where a *small central incision* of the anterior capsule is desired, close to the limbus but within the transparent cornea. The technique differs somewhat from the previous operation in that the length of the cut is less and the point of the needle penetrates the lenticular substance somewhat deeper, as shown in the accompanying diagram.

Removal of Cataract by the Suction Operation.

The removal of cataract by *suction* or *aspiration* is mentioned by Rhazes as the invention of Antyllus, who flourished about the fourth

century A. D. According to Albucasis, this method was in use in both Persia and Arabia.

The operation was not entirely forgotten in the later centuries, as Guillemeau claimed that the lens was not removed thereby but simply the aqueous humor. Barbette in the seventeenth century ridiculed the method.

During the subsequent two centuries it fell into complete disuse, until it was revived by Peccholi in 1829. He made a corneal section (after the discission had fully matured the cataract) and through the opening introduced a hollow needle by which the soft lens matter in the anterior chamber was drawn off by a pump.

The next recorded advocate of the operation was Laugier,[14] who entered the needle through the sclera, perforated the posterior capsule and removed the soft lens matter by means of a foot-pump.

The operation was adopted in England in 1863, by Teale,[15] Bow-

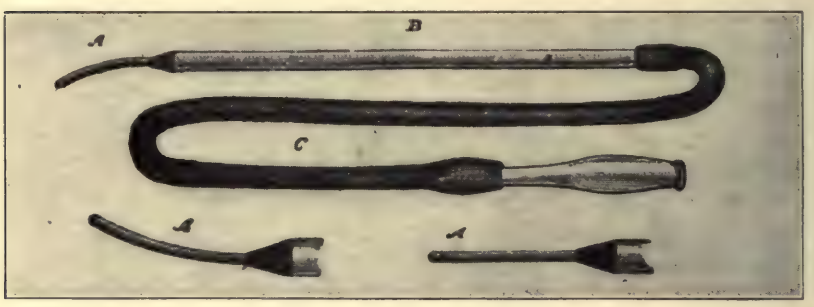


Fig. 660.

Teale's Suction Apparatus for the Aspiration of Cataract.

***A, A, A*, points to be introduced into the anterior chamber; *B*, glass tubing; *C*, rubber tubing and mouth-piece.**

man,[16] Lawson,[17] and Greenway,[18] and for a time was quite in vogue. Teale devised a special canula to which was attached a glass and rubber tube, using the mouth for suction, as seen in Fig. 660.

Bowman devised a special syringe with which to make suction and thereby avoided aspiration by the mouth. (See Fig. 661.)

About ten years subsequent to the revival of the operation in England, it was employed at the Mass. Charitable Eye and Ear Infirmary.

---

[14]Laugier. *Annales d'oculist.* XVII, p. 29.

[15]Teale, *R. L.* A Suction Curette for Extraction of Soft Cataract. *Oph. Hospital Reports.* IV, 2, 1864, p. 197; see, also, On Extraction of Cataract by Suction, *The Lancet*, I, 1880, p. 29.

[16]Bowman. *The Lancet.* 1864.

[17]Lawson. *British Medical Journal.* 1864.

[18]Greenway. *The Lancet.* 1864.

Hasket Derby[19] states: "As regards results from the suction operation, the reports of the Mass. Charitable Eye and Ear Infirmary for the last eleven years show the performance of 107 operations by suction." In 65 cases the results are as follows: Full suction, 46; partial, 18; loss, 1. In five instances the visual result was perfect. In 1887 Coppez[20] in Belgium and Redard in France, called attention to the advantages of the operation. The latter made an improved apparatus on similar lines to Teale's instrument.

Rogman[21] in 1899, operated on the clear lens in high myopia in 20 cases by discission and suction, with no loss.

Howe[22] and others in America have also extensively employed the method.

The *operation* of aspiration should be confined to soft, liquid and traumatic cataracts. In old patients, with a hard nucleus, it is unsuitable and in young subjects with partially clear lens matter, as in the

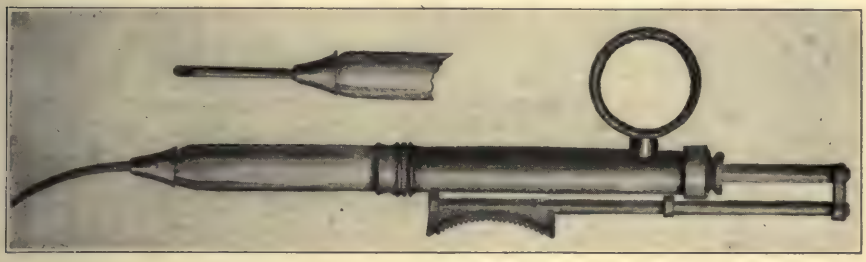


Fig. 661.
Bowman's Syringe-pump for the Aspiration of Soft Cataract.

perinuclear type, it should not be attempted until a discission has softened the entire lens mass.

The pupil should be dilated *ad maximum*. The corneal incision should be made with a keratome 4 mm. from the limbus; in the *left eye* in the superior nasal quadrant; in the *right eye* at the superior temporal quadrant. Then a large opening is made by the point of the instrument in the anterior capsule. Introduce the canula, with its point towards the cornea, into the anterior chamber through the cut capsule against the substance of the lens. Then, suction is made either by the syringe-pump or by the mouth.

---

[19]Hasket Derby. *Handbook of the Medical Sciences*. New York, 1885.
[20]Coppez. De l'operation de la cataracte molle par aspiration. *Bull. et Mém. de la Soc. Franc. d'ophtalm.*, 1885, p. 145.
[21]Rogman. Traitement opératoire de la myopie forte. *Annales d' oculistique*. Vol. 121, 1899, p. 1.
[22]Howe. On the removal of hard cataract by suction. *Trans. Am. Oph. Soc.*, 1893, p. 594.

Care should be taken to retain the end of the canula within the capsular wound and not to push it behind the iris or into the vitreous.

The *dangers following the operation* are similar to those attendant upon discission and call for the same precautions and treatment.

THE OPERATIVE TREATMENT OF HIGH DEGREES OF MYOPIA.

Historical.

Surgeons of the eighteenth century were aware of the visual advantage gained by myopes after the successful removal of cataract. Boerhaave[23] in 1708 was the first to publish his observations and called attention to the fact that myopes after the removal of the cataract could see without the aid of glasses. He put the following query: *"Decimo! Quaeritur cur myops a cataracta per operationem curatus non indigeat vitris convexis ut alii? Lente suppressa focus in puncto a cornea remotiori figitur, ut in retinam ipsam incidat, qui antea retinam colligebatur."* Woolhouse[24] in 1717, likewise commented on the fact that myopes after the removal of the opaque lens could see without the aid of glasses. Higgs[25] in 1755 noticed that depression of the cataractous lens cured myopia. Deshais-Gendron[26] in 1770 and Janin[27] in 1772 both called attention to the benefits accruing to myopes after the removal of cataract, as they were able to dispense with the use of glasses for far and near.

The Abbe Desmonceaux[28] was the first to advocate the removal of the clear lens for the cure of myopia: *"Les myopes de 2 à 3 pouces de foyer sont des sujets bien malhereux, puisqu'ils ne voient que confusement ce qui est á leurs pieds ils sont par consequent peu propres au travail. C'est pourquoi lorsqu'ils sont encore jeunes mon avis est d'extraire le cristallin."* He never performed the operation because, as he naively puts it, being a clergyman, it would not have been consistent; furthermore he would not have the courage to do it. Consequently he referred the cases to expert surgeons and especially mentions Baron Wenzel who had performed many of these operations at his suggestion. Wenzel, however, makes no mention in his writings of having removed the clear lens in high myopia. During the latter part of the eighteenth to the early part of the nineteenth centuries many surgeons referred to the subject of operative interference in high myopia, name-

---

[23] Boerhaave. *De morbis oculorum*, Göttingen, 1708, page 231.

[24] Woolhouse. *Dissertations savantes et critiques sur la cataract*, 1717.

[25] Higgs. *A Practical Essay on the Cure of Venereal, Scorbutic and Arthritic Lesions*, London, 1755.

[26] Deshais-Gendron. *Traité des Maladies des yeux.* Vol. II, page 336.

[27] Janin. *Memoires et observations anatomiques physiologiques et physiques sur l'oeil et ses maladies*, 1772.

[28] Desmonceaux. *Traité des maladies des yeux et des oreilles.* 1786, Vol. II, p. 140.

ly: Richter, Gleize, Beer, Andreas, Weller, Desmoulins, Demours, and Benedikt, but there is no evidence that any one of these had operated on the clear lens. The subject was discussed from a theoretical standpoint, the writers expatiating on the risk and danger likely to follow such an operation.

Mackenzie[29] in 1830 refers to Sir William Adams as having removed the clear lens for the relief of conical cornea. Adams had operated on a woman seventy years of age, suffering from conical cornea and cataract and was gratified to find that the patient could see more distinctly without glasses than is usually the case. The experience thus gained, determined him to remove the clear lens in conical cornea at the first opportunity. The following year a suitable case presented in the person of a domestic; a young woman, on account of conical cornea, was so blind that she could not continue her employment. She could walk without a guide and could see at a distance of three or four feet, but had entirely lost the power of seeing small objects or reading. He performed discission on one eye, and the patient returned to the country before the eye had entirely recovered from the operation. It was almost a year before she was seen again by Adams, who found that she could read the finest type, without a glass, at a distance of ten to twelve inches from the eye. The vision was improved for near, with weak convex lenses, but distant vision was best without glasses.

Radius[30] in 1836, advised the removal by discission of the clear lens for the relief of high myopia, but there is no evidence that he performed the operation. In fact, the subject is not even mentioned or referred to in books on ophthalmology until the Heidelberg Congress in 1858.

Adolph Weber, of Darmstadt, reported a successful case and Mooren advocated operating in high myopia.

Von Graefe and Donders,[31] however, deprecated the idea, refering to the great risk involved, besides the loss of accommodation. Some six years later, Donders expressed himself as follows in regard to the operation: "But I need not say that such a momentous undertaking is doubly dangerous when a myopic eye and a transparent lens are concerned. To expect that even in the most favorable case, any real advantage is to be expected would exhibit culpable rashness. Not only would the *staphyloma* posticum continue equally threatening, but it would sacrifice the accommodation, a disadvantage which somewhat larger images obtained by neutralizing glasses would not counterbalance."

---

[29]Mackenzie. *Diseases of the Eye.* London, 1830, page 528.
[30]Radius. *Walther und Jäger's Handbuch,* 1839.
[31]Donders. *On the Anomalies of the Refraction and Accommodation of the Eye.* London, 1864.

Two weeks after the adjournment of the Heidelberg Congress, Mooren operated on the clear lens of a young man, thirty years of age, for high myopia with phthisis bulbi as the outcome. With the exception of a few isolated operations, the matter remained in abeyance until 1888, when Fukala reported the results of his operations in fourteen cases of high myopia in young subjects from whom he had removed the clear lens.

The report was a revelation to the medical profession. For the first time the question ceased to be theoretical and abstract and became practical and concrete. It required no little moral courage to rehabilitate an operation frowned upon by the founders of modern ophthalmology.

Fukala's[32] experience might have been that of Weber's, thirty years before, had not the era of asepsis been introduced in the meanwhile.

As an appendix to a translation[33] of one of Fukala's papers I made the following note of a case operated on by a Chicago colleague: In 1880, an Irishman, æt. 35, a bookkeeper, presented himself for treatment. He had a myopia of ½ (20 D.), his far point being 2″ from the cornea. The right lens was extracted by the flap operation without iridectomy and came away entire. With minus 1/8 or 1/7 (minus 5 or minus 6 D.) he had, three months after the operation, vision of 20/xxiv minus and was able to do bookkeeping. The left lens was not disturbed.

Vacher[34] about the same time, without the knowledge of Fukala's work, had extracted the clear lens for high myopia with the avowed object of preventing retinal detachment and progressive choroidal degeneration.

Arguments for and Against the Removal of the Clear Lens in High Myopia.

High myopia is a great handicap entailing a train of physical discomforts and disabilities that disqualify persons for and exclude them from many occupations where good vision is a *sine qua non.* The strong convergence necessary to see distinctly at a very near point is often accompanied by spasm of the accommodation causing vascular

---

[32]Fukala. Vortrag in der k.k. Gesellschaft der Aerzte am Wien., *Wiener Klin. Wochenschr.*, Nov. 8, 1889, p. 888.

See, also, a paper by the same author; Operative Behandlung der hochstgradigen Myopie durch Aphakie. *Archiv f. Ophthalm.*, Vol. 36, 2, 1890, p. 230. Also *Heilung höchstgradiger Kurzsichtigkeit*, Leipzig, und Wein, 1896.

[33]Treatment of High Degrees of Myopia by Removal of the Lens. *The Am. Jour. of Ophthalm.*, Nov., 1890, p. 347.

[34]Vacher. *Bulletins et Mem. de la Soc. franc. d'ophtal.*, 1890, p. 197. Also, Traitement de la myopie progressive chorioidenne et prophylaxie du décollement de la rétine par l'extraction du cristallin transparent, 1891.

disturbances and choroidal stretching leading to degenerative changes in the fundus oculi.

The full correction of high myopia is rarely worn with comfort and often the attempt is likely to be followed by nausea, headaches, dizziness and general malaise. Strong concave lenses act as prisms, reduce the size of objects and lead to false estimates of distances.

The *removal of the clear lens in high myopia is a rational procedure,* resulting in great benefit in suitable cases. On the other hand, indiscriminate operating leads to disastrous results and tends to discredit an otherwise beneficial operation.

The *vision* improves after the operation in varying amounts from 1/6th to 1/3d of the normal. The retinal images and fields of vision are enlarged. Distant vision is obtained with or without strong lenses, (at most a weak convex or concave glass), while near vision generally requires a comparatively low power convex glass. The excessive convergence, with its spasm of accommodation, is no longer necessary. The range of accommodation is quite sufficient, often amounting to several diopters. No patient with high myopia, after the successful removal of a clear lens, would willingly resume the former *status quo.*

The *operation should be confined to* high degrees of myopia, as it is in such cases that the greatest benefit is likely to accrue. Lower degrees mean, after removal of the lens, separate, strong, convex lenses for far and near vision.

There is no absolutely accurate means of determining what the resulting refraction is going to be after the removal of the lens. Formulæ to determine it have been published by Badal, Ostwalt, Eperon, Hirschberg, Stadfelt, and Pflüger that give only approximate results.

An emmetrope *(i. e.,* a subject with a slight amount of hyperopia), after cataract extraction, sees distant objects with a + 10 D. and a cylinder of greater or less amount. However, a myope of 10 D. does not become emmetropic after the removal of the lens. Eyes with an equal amount of myopia prior to operation, have shown differences as high as 10 D. after the removal of the lenses.

The refractive index of the lenses of emmetropia, as shown by Donders and Becker, may vary from 2 to 3 D. Besides the axial length of the eye-ball (which is the chief factor in the different refractive types) the radius of the cornea, the depth of the anterior chamber, as well as the shape, size and density of the lens are modifying conditions to be considered.

Donders found the *average radius of the cornea* in the three refractive types as follows: Hyperopia, 7.96 mm.; emmetropia, 7.85 mm.; myopia, 7.87 mm.. Mauthner found the following: Hyperopia, 7.623 mm.; emmetropia, 7.708 mm.; myopia, 7.584 mm. Von Reuss reported these

findings: Hyperopia, 7.739 mm.; emmetropia, 7.44 mm.; myopia, 7.52 mm.

According to Donders' and Von Reuss' tables, the emmetropic eye has the shortest corneal radius, while Mauthner found first, the myopic eye, with the hyperopic next in order. In other words, the measurements by the ophthalmometer of the cornea in the three refractive types vary but little from each other. Strictly speaking, there are only two refractive conditions, hyperopia and myopia, inasmuch as the emmetropic eye means a small amount of hyperopia or hyperopic astigmatism.

In measuring the cornea with the ophthalmometer, the eye should be in a condition of absolute rest (with paralysis of the accommodation) and a passive state of the extrinsic ocular muscles.

Indications for Operation in High Myopia.

The social status of the patient, the ability to continue employment, and the earning capacity are factors to be considered. If the vision is so poor that work at fourteen inches is no longer possible, or if no remunerative employment can be obtained, so that the individual becomes dependent on relatives or the State for support, the operation is urgently called for. Besides, there are occupations where the wearing of glasses is almost prohibitory (as for cooks, coachmen, sailors) where vapor, rain or prejudice militates against their use.

When the myopia is so high that no lens gives satisfactory results or where distant vision is little better than one-tenth of normal; and if the macula lutea be intact with fair vision for near, the operation is justifiable. As to the amount of myopia likely to be benefited by an operation, it varies according to the ideas of different surgeons. Some fix 12 D. as the lowest limit. The chief objection to such a small amount is a resulting high degree of hyperopia in the aphakic eye, requiring strong convex lenses, both for far and near. It appears to me that 16 D. is the lowest amount and the one most likely to give the best results, viz., a weak convex lens for near work and no glass for the distance.

The patient should be made fully aware of the risk to be run in the operation; that the eye-sight may be lost as a direct result of the attempt to remove his lens. When a patient is blind from cataract, there is everything to be gained by an operation, and if unsuccessful, the eye is still blind. Not so, however, in high myopia, as the operation may lead to the loss of a seeing eye.

Contra-indications. Where the *patient has only one eye,* or where in the fellow eye there is a detached retina, it would not be wise to risk the loss of the remaining sound eye.

Destructive changes at the macula lutea, with defective near vision,

should be excluded. Hemorrhages into the vitreous, choroid, or retina are contra-indications, but the ordinary chorio-retinal changes of high myopia even when they involve the macula lutea but still leave the patient with fair vision, do not bar the operation.

Dacryocystitis, trachoma in the acute stage, or inflammation of the eye-lids with *purulent secretion, ozena,* or *diseases of the nasal sinuses,* are contra-indications, as are a hazy cornea or media that would militate against the final results. General constitutional diseases interfere with the good results in proportion as the entire system is enfeebled.

Although two decades have almost elapsed since Fukala's first report, there are still some moot points yet to be definitely settled, viz., the ultimate effects of the removal of the lens in regard to, first, axial length; second, effect on the fundus changes; third retinal detachment.

Mooren,[35] as a prophylactic measure removed the clear lenses from young persons with (progressive) myopia, ranging from 2 to 5 D., with unsatisfactory results. The axial length increased and the fundus changes continued.

Most other operators found that the antero-posterior axis remains unchanged, or, at most, there is very little increase in length. At present, it is not possible to state positively that the removal of the lens always stops the increase of the axial length, or brings the fundus changes to a standstill. However, judging by the experience of the majority, the axial length does not increase, and if it does, it is only exceptionally; and the same holds good of the fundus changes.

Retinal detachment occurs not infrequently in high myopia, irrespective of the removal of the lens, and the question naturally arises, how much of a factor is the operation in its causation? Can it be held responsible, when we know that retinal detachment and choroidal hemorrhage rarely follow cataract extraction in ordinary cases of emmetropia and high myopia?

The following table statistics dealing with this subject are quoted from K. Bjerke's[36] paper:

---

[35]Mooren. Die Operative Behandlung der natürlich und künstlich gereiften Starformen, Wiesbaden, 1894, and *Die Operative und Medizinische Behandlung kurzichtiger Störungen,* Wiesbaden, 1897, p. 85.

[36]Bjerke. Die operative Beseitigung der durchsichtigen Linse wegen hochgrdiger Myopie, *Zeitschr. für Augenheilk.* Bd. VIII, 1902, p. 137-175.

SURGEON	OPERATION	Detachment of the Retina, per cent.
Schweigger	Discission and Linear Extraction	7 in 50 cases, 14
Thier	ditto	4 " 50 " 8
Frölich	Discission through the entire lens and Linear Extraction	4 " 56 " 7
Von Hippel	Discission and Linear Extraction	10 " 184 " 5.4
Schrieber	ditto	1 " 19 " 5.2
Silex	ditto	1 " 20 " 5
Rogman	Discission and Suction	1 " 20 " 5
Sattler	Discission and Extraction	4 " 85 " 4.7
Sattler	Primary Extraction	1 " 30 " 3
Darier	ditto	4 " 142 " 2.8
Blessig	Discission and Extraction	1 " 50 " 2
Pflüger	ditto	1 " 100 " 1
Vacher	Primary Extraction	0 " 61 " 0
Haab	Discission and Extraction	0 " 50 " 0
Gelpke	ditto	0 " 50 " 0
Schmidt-Rimpler	ditto	0 " 12 " 0
Schleich	ditto	0 " 60 " 0
Völckers	ditto	0 " 17 " 0
Hirschberg	ditto	0 " 20 " 0
Silvestre	ditto	0 " 10 " 0
Röhmer	ditto	0 " 8 " 0
Maxwin	ditto	0 " 10 " 0
Logetschenkow	ditto	0 " 40 " 0
Hertzog de Grandleur	ditto	0 " 20 " 0
Batten	ditto	0 " 6 " 0
Bjerke	ditto	0 " 6 " 0

Referring to the foregoing tables, 1,176 cases were operated on by twenty-five surgeons. The procedure employed to remove the clear lens by eight surgeons in 262 cases is not specified. 914 cases were operated upon by seventeen surgeons by the following methods: 9 surgeons operated by discission and extraction in 474 cases; 5 surgeons operated by discission and linear extraction in 329 cases; 1 surgeon operated by discission and suction in 20 cases; 2 surgeons operated by primary extraction in 91 cases.

The greatest number of operations were discission and extraction. Next in order comes discission with linear extraction; primary extraction without discission; and the lowest number by discission and suction. In not a single instance was discission solely depended upon to remove the clear lens.

Six surgeons (method specified) had no retinal detachment. Six surgeons in 250 cases (method specified) had no retinal detachment. Eight surgeons in 262 cases (no method specified) had 2.8 per cent. of loss of the eye.

If we consider the entire 1,176 patients, operated on by twenty-five surgeons, the proportion of retinal detachment was about 4.83 per cent.

Frölich[37] collected the statistics of retinal detachment in myopes

[37] Frölich. Beiträge zur chirurgischen Behandlung hochgradiger Kurzsichtigkeit. *Archiv. für Augenheill.* Vol. 35, 1897, p. 267.

over 10 D. and compared those not operated on with those operated on for high myopia. He found 3.3 per cent. of the latter with retinal detachment, against 2.2 per cent. retinal detachment in patients not operated on.

Von Hippel found 6.7 per cent myopes over 10 D., who had not been operated on as compared with 5.4 per cent. in those who had one or both lenses removed.

Retinal detachment (it would appear from the experience of these surgeons) occurs somewhat more frequently in eyes, from which the transparent lens has been removed, but the percentage is not large, when compared with that which takes place in high myopia. The different results obtained by various surgeons suggests that this accident results not so much from a particular form of operation as in the carrying out of the technic.

In High Grade Myopia should one or Both Eyes be Operated On?

Advocates of the need of binocular vision are outspoken in favor of removing both lenses. To my mind, it is a question for the patient to decide; when a sufficient period of time has elapsed after the first operation, let him fully determine what he needs. The surgeon should not influence the patient on purely theoretical grounds. Besides the risk of a double operation, the loss of time must be considered. As the result of some experience in these matters, I feel that a decision should lie wholly in the hands of those most interested in the result. A patient blind from cataract in submitting to an operation followed by an untoward result, is in a totally different position from one who loses a seeing eye as a result of an operative procedure.

The Operation of Election for High Degrees of Myopia.

There are three operative methods open to the surgeon: First, *discission;* second, *discission with linear extraction;* and third, *primary extraction.*

The *easiest and safest procedure for the removal of the clear lens, up to the twenty-fifth year, is discission.* Exceptionally, this age limit may be extended, but much beyond the twenty-fifth year the nucleus is apt to be too hard. The chief objection to discission is the slowness of absorption; it often takes months before the process is complete. Although this objection is a valid one, the patient need not lose *all* the time. Work may be resumed after the irritation has ceased in the eye operated on.

At the end of six to eight weeks a second discission, more free than the first and penetrating deeper into the lens, may be performed. It is to be assumed that by this time the process of absorption resulting from the first needling, has come to a stand-still. In adults, it may re-

quire a year to eighteen months before the process of absorption, due to the discissions, is complete.

The density of the lens even up to the twenty-fifth year varies considerably so that in one case the capsular opening may result in a mere opaque line, while in another instance there may be marked opacity and swelling of the lens substance. As a rule, however, a large discission with deep penetration of the lens is apt to be followed by much reaction, especially swelling and opacity of the lens fibres, and in twenty-four to forty-eight hours, by increased tension, etc.

Most surgeons prefer to do a *free discission followed by a linear extraction.* If the reaction is slight ice cold compresses and the free use of atropine should be used, that the opacity and swelling of the lens may proceed moderately, without too many signs of irritation.

It is well to wait a sufficient time, so that the lens becomes fully opaque before proceeding to the next step, linear extraction. However, if the patient complains of much ocular pain, headache, peri-corneal injection, contraction of the pupil, haziness of the cornea, and increased ocular tension, delay is dangerous and the swollen lens must be evacuated on the fourth or fifth day following the discission.

Dangers and Complications of Operations for High Myopia.

The untoward results liable to follow are: First, glaucoma; second, iritis, irido-cyclitis or panophthalmitis; third, infection.

The *glaucoma* occurs in two forms, inflammatory and non-inflammatory. Acute inflammatory glaucoma is the most frequent result of a too free discission, due to the irritation of the rapidly swelling lens substance, and comes on usually within the first five days following the operation. If severe, with neuralgic pains in the head and globe, nausea, vomiting, increased tension, and a hazy cornea, a linear extraction should be done without delay, permitting the evacuation of the swollen and opaque lens. This act dissipates all signs of inflammation, provided the operation is done at the onset of the symptoms.

There is a non-inflammatory or chronic form that occurs months or even years after operation, due to the contraction and thickening of capsular bands pulling on the ciliary process. Cutting these bands so as to prevent the traction, stops the process and this is done best with the scissors. I have seen six such cases where iridectomy proved of no avail and relief was only obtained by severing these capsular bands.

Iritis may occur, likewise irido-cyclitis may result from the too rapid swelling of the lens substance and are best treated by leeches to the temple, the free use of atropine and hot compresses, temperature ranging from 120° to 130° F. continuously applied to the closed eyelids of the affected eye.

These conditions when severe are difficult to discriminate from in-

fection, especially when the process results in panophthalmitis. It may be an open question as to what role infection played in leading to this result, the germ possibly being introduced at the time of operation.

OPERATIONS FOR THE RELIEF OF DISLOCATION OF THE LENS.

Surgical interference is not always necessary or even justifiable in all forms of displacement of the lens. In the hereditary and congenital form *(ectopia lentis)* where the lens is clear and the vision satisfactory for the patient's needs, nothing should be done other than correct the refractive error with sphero-cylinders. The vision is in some cases better than 20/40ths. However, such lenses do sometimes become wholly luxated or so opaque as to need surgical aid.

Displacement of the lens due to traumatism or disease, *may be partial or complete.* In the partial form, sub-luxation, where the rupture of the zonula fibers is slight, and the lens is but slightly tremulous, it may remain clear for years. When, however, the injury is extensive, and with such loss of the supporting fibers that the lens moves like a door on hinges, trouble is likely to ensue. The free, unsupported part of the lens strikes the iris and sets up irritation that results usually in a glaucoma. An iridectomy done so as to include that part of the iris involved, often gives relief.

In sub-luxation, where the lens exhibits little movement and causes no irritation, it is quite obvious that nothing is to be done. However, in the course of time, such lenses are apt to undergo changes and the displacement may become complete, or the lens become entirely opaque, so as to call imperatively for its removal.

Operations for the Removal of a Dislocated Lens.

The extraction of a sub-luxated lens presents some difficulties which suggest themselves when considering the location and kind of corneal section, the cystotomy, the expulsion of the lens, or its removal with a wire loop or spoon.

The *corneal section* is best placed opposite the fixed part of the lens. If the lens is suspended from above, then the lower part of the cornea is the point of selection; if the zonula fibers are intact on the nasal or temporal side, then the upper section is preferable. No cystotomy should be attempted if the lens has much motion.

After completion of the corneal section, the eye speculum is removed and an assistant separates the eye-lids, keeping all pressure off the globe. Then introduce into the eye, a wire loop, which is to be passed behind the lens and the cataract extracted. Vitreous loss is to be expected, but the amount will depend on the deftness and quickness of the operator.

Complete displacement, luxation, is in the majority of cases, into the vitreous. Some displaced lenses rest on the pupillary margin, or wholly in the anterior chamber. When partly or entirely in the anterior chamber, union is likely to occur between the lens and the cornea, or iris.

A luxated lens becomes in due course of time cataractous, and generally sets up inflammatory glaucoma, which an iridectomy or sclerotomy does not relieve. When the lens is bound down by inflammatory exudates to the ciliary processes, or is fixed at the bottom of the vitreous chamber, contact with the ciliary body or retina lights up a slow, insidious irido-cyclitis or choroiditis that destroys the eye and, occasionally incites sympathetic ophthalmia.

The removal of a lens adherent to the ciliary body, even if it could be accomplished, leads to no satisfactory result as the insidious uveitis is not checked by extraction of the crystalline; the only proper procedure is an enucleation.

The *extraction of a lens from the anterior chamber,* or one partly pushed through the pupil, especially if adherent to the cornea or the iris, presents no great technical difficulty. In making the corneal section the knife must not be carried in a horizontal line through the anterior chamber; the handle should be depressed and the blade pushed over, or through the soft cortical portion until the point reaches the opposite side. Then elevate the handle, make the counter-puncture and complete the section.

A Lebrun section (q. v.) (in the upper third of the cornea) gives the best results. No iridectomy is necessary. A spoon or loop is then introduced into the anterior chamber, passed behind the lens, and the lens extracted. If the section is carefully done, without undue pressure on the globe and without passing the knife through the hard nucleus, the lens remains *in situ,* does not fall into the vitreous and can be readily extracted. If it should sink into the hyaloid chamber, at once pass the loop behind it, there is no reason why it should not be extracted without great loss of vitreous.

For the extraction of lenses freely floating in the vitreous humor, various methods have been proposed. Agnew[38] used a *bident* (see Fig. 662), passed 6 mm. from the limbus through the sclera, with which he harpooned the lens. The latter was then pushed into the anterior chamber and extracted through a corneal section made below with a keratome.

Agnew's procedure was imitated successfully by Webster and

[38]Agnew. An Operation with a Double Needle, or Bident, for the Removal of a Crystalline Lens Dislocated Into the Vitreous Chamber. *Trans. Am. Oph. Soc.,* 1885, p. 69.

Pomeroy.[39] Noyes[40] placed the patient on a table, resting on his chest and abdomen, face downward. He then passed a cataract needle through the sclera, transfixed the lens and extracted it.

Knapp's[41] method consists in making the usual corneal section without iridectomy or capsulotomy, then, removing the eye speculum, he made use of the lower eye-lid to press on the sclera and expel the lens. If it did not present, he introduced into the eye a spoon or loop and completed the extraction.

Knapp's method is by all means the best procedure for totally luxated lenses, free in the vitreous. As a rule, pressure on the lower eye-lid over the sclera, with counter-pressure by means of the upper lid, will bring success in most cases, and without great loss of vitreous.

I have been fortunate in several instances to secure the lens without introduction of either spoon or loop. I direct the patient not to look downward, but rather slightly up, while the expulsive pressure is being made. The downward trend of the globe is apt to induce escape of vitreous by causing too great gaping of the corneal wound, owing to

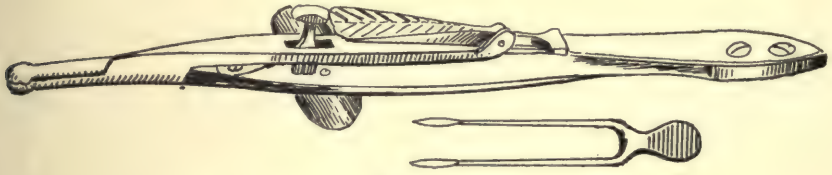


Fig. 662.

Agnew's Bident for the Extraction of Dislocated Lenses.

pressure of the globe on the orbital floor. Loss of vitreous should be supplied by injecting into the eye (to fill up the globe) a sufficiency of normal salt solution.

When it becomes necessary to introduce an instrument into the vitreous to extract a luxated lens, unless it be a small, calcareous one, the wire loop is much to be preferred. The spoon is likely to push the lens forward in front of it, owing to a layer of vitreous filling its concavity, but the wire loop permits the vitreous to pass through the open center and come in close contact with the lens; and thereby permits the cataract to be lifted out of the eye. The wire loop is sometimes serrated on its anterior surface, so that it has a better hold on the lens capsule.

As a result of trauma, the lens is sometimes forced through a rup-

---

[39]Webster and Pomeroy. Three Consecutive and Successful Extractions of Luxated Lenses by Means of the Agnew Bident with Two Additional Cases from Other Sources. *Trans. Am. Oph. Soc.*, 1888, p. 168.

[40]Noyes. *Diseases of the Eye.* New York, 1890.

[41]Knapp. *Archiv. für Augenheilk*, 1883.

tured sclera *beneath the conjunctiva*. By making a suitable opening through the latter, the lens can be readily removed. No sutures are necessary. A pressure bandage suffices to bring the parts in apposition.

THE OPERATION OF COUCHING.

Definition of the Term.

Couching, depression, reclination and *displacement* are terms used to designate the removal of the lens from the axis of vision into the vitreous humor.

Couching and *depression* indicate the operative displacement of the lens into the lower part of the vitreous chamber.

Reclination is the deposition of the lens in a horizontal plane, level with the lower border of the iris.

Depression was the chief operation done by the Ancients to obtain a clear pupil in cataractous diseases. For almost two centuries after the introduction of extraction by Daviel, it held its own as the equal, if not the superior, method and many competent surgeons gave it the preference. A continual war of words was waged as to the merits of depression *versus* extraction, until the beginning of the latter half of the nineteenth century, when couching methods finally fell into disuse.

The operation is still practised in India by itinerant operators. Major Elliott,[42] in a recent paper, describes these Indian operations and states that 40 per cent. of the eyes are lost through sepsis.

Drake-Brockman[43] has written an interesting account of couching as performed by the "suttiahs," or Indian oculists, from the earliest times, with a description and drawings of the chief instruments used by them. During a long residence in India he saw much of these native operators and made a collection of their couching utensils.

The chief instruments (Drake-Brockman, The Indian Oculist, His Equipment and Methods, *Indian Medical Gazette*, Vol. 45, No. 6, 1910) usually found in the North Indian "*Suttiah's*" armamentarium are one or two "*sillais*," or couching needles; a "*chimtee*," or pair of forceps of very rough construction; a hook or "palak utarne ka kanta," this latter being used as a lid retractor, as well as for treating pterygium; and lastly the "nastar," or lancet, which is used for the sclerotic puncture, being protected to within about three mm. of its point by cotton thread wound round it (in order to prevent too deep penetration of eyeball), and which in most cases is usually filthy and as septic as possible. Col. Drake-Brockman has seen many of these as simple vaccination lancets that have been discarded and turned to this use. All the instruments are enclosed in a cloth or leather case to roll up and be easily carried. The native oculist in addition carries in the roll a few drugs, "soormas," "unjan," alum, etc., for application to eyes for various ailments. Few, if any, of them carry implements for venesection, cup-

[42] Elliott. Some Notes of 125 Cases of Posterior Dislocation of the Lens, as a Result of Operations by Native "Couchers." *The Ophthalmoscope*, Vol. V, 1907, p. 193.

[43] Drake-Brockman (p. c.). Also see *Trans. Ophthalm. Soc. U. K.*, 1897.

ping, etc., but the author has seen such in their kit, together with a few lancets for opening abscesses, etc., but possibly these form a more or less permanent part of the equipment of the Mohammedan Vydian, as being more compatible with the craft of the "Jarrah," who is usually a Mohammedan and belongs to the large class of "hakims" so prevalent in all the large Indian cities.

Quite recently Ekambram[44] witnessed six operations in India. Most of these operators belonged to one village and traveled from place to place throughout the country, prior to the harvest (during the dull season) and couched cataracts in a very crude manner.

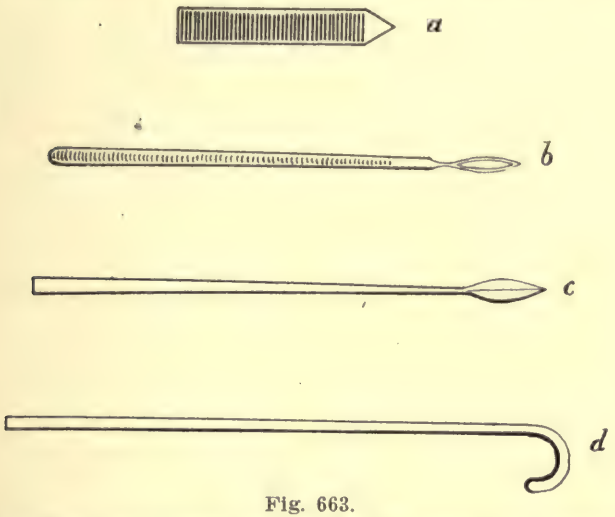


Fig. 663.

North Indian Instruments used by the "Suttiahs" for Couching.

a, Lancet for the sclerotomy; *b* and *c*, Couching needles; *d*, Lid retractor. **(Drake-Brockman).**

During the last forty years attempts have been made by several surgeons to revive the operation.

Despres,[45] Elias,[46] Truc,[47] Holth,[48] Power,[49] and Roure,[50] have advocated depression in exceptional cases; for instance, in very old and feeble patients, in persons suffering from severe bronchitis or asthma and in hemophilia, or where one eye has been already lost by choroidal

[44]Ekambram. *Indian Med. Gaz.*, Vol. XLV, March, 1910, p. 110.

[45]Despres. D'énucleation du cristallin dans l'operation de la cataracte par déplacement. *Gaz. des. Hop.*, 1873, p. 596.

[46]Elias. Sur la habilitation de la réclinaison dans l'operation de la cataracte. *Gaz. Med. d'orient*, April, 1875.

[47]Truc. Deux cas d'abaisement de la cataracte. *Cong. Intern. d'ophtal.*, 1900.

[48]Holth. From the Norwegian in *Nagel's Jahresbericht*, 1901.

[49]Power. A Plea for the Occasional Performance of Depression for the Cure of Cataract. *Ophth. Review*, 1901, p. 601, and the *Am. Jour. of Ophthal.*, 1901, p. 229.

[50]Roure. Deux cas d'abaisement de la cataracte. *Révue Générale d'Ophtal.*, No. 2, 1901, p. 330.

hemorrhage following extraction; in cases of ozena; in long-standing diseases of the adnexa and in the insane.

Tyrrell[51] states: "The operation of depression, like that of extraction, is applicable to cases of hard cataract; but should in my opinion, only be performed when the latter operation is impracticable or hazardous, namely: when the globe is very deeply seated in the orbit, when the palpebral aperture is much contracted, when the anterior chamber is very small, when adhesions exist between the pupillary margin of the iris and the anterior capsule of the lens, when the globe has lost much of its natural elasticity, when the patient is extremely feeble or when he is the subject of chronic cough or asthma."

None of these reasons would deter a surgeon from extracting at the present day. The sunken globe can be readily lifted forward by fixing the superior rectus muscle. The narrow palpebral fissure can be very readily increased in size by cutting the outer canthus. The narrow anterior chamber offers no special difficulty when a preliminary iridectomy has been done, and the same holds good as regards posterior synechiæ. With the patient in his best possible condition, neither cough, asthma, nor feebleness is a sufficient excuse for choosing any depression operation.

There is, however, one valid reason for not performing an extraction, namely, *where the fellow eye has been lost by choroidal hemorrhage* (see Axenfeld's operation) *following the extraction of an opaque lens.*

It is estimated that 50 per cent of all cases of depression are lost through glaucoma, irido-cyclitis, or infection. The depressed cataract acts as a foreign body, setting up acute glaucoma, or by pressure bringing on an attack of *irido-cyclitis,* which may lead to occluded pupil, or to the formation of a cyclitic membrane with possible sympathetic inflammation of the fellow eye; or the eye through sepsis, may be lost from a panophthalmitis.

Steps of the Operation.

Depression was continuously done in the following manner: The pupil was fully dilated, the lids were separated and held apart, either with a speculum or by the aid of an assistant. A cataract needle was entered in the sclera several mm. from the limbus below the horizontal plane on the temporal side. It was then passed through the sclera in front of the iris into the anterior, or behind it into the posterior chamber, depending on which route had been selected. If the former, the point of the instrument was pushed into the area of the pupil the handle was then depressed until the point reached the upper periphery

[51] Tyrrell. *On Diseases of the Eye,* Vol. II, 1840, p. 441.

of the lens. Gentle pressure downwards was made by elevation of the handle until the lens disappeared from the pupillary space. The handle was then held in position for a minute or two, after which the point was slowly raised to see if the cataract had been permanently dislocated; if not, the depression was repeated.

The Reclination Operation of Willburg.

Willburg,[52] to obtain better results than those furnished by depression, modified the operation so that the lens occupied a horizontal position in the vitreous humor; the anterior capsule looking upwards and the posterior downwards.

The steps of Willburg's operation are the same as in depression except that the point of the needle is placed just above the antero-posterior axis of the lens and pressure made backwards and downwards, so that it disappears from the line of vision and occupies a horizontal plane in the vitreous. This operation gave somewhat better results than depression.

Reclination by Means of Scleronyxis.

Axenfeld has[53] sought to avoid some of the dangers of reclination by doing a preliminary iridectomy. The needle point is passed through the sclera in the usual way and the pressure against the lens is mostly exercised in the coloboma, as shown in the illustration. However, although the iridectomy may render less likely a secondary glaucoma it does not, unfortunately, preclude the possibility of expulsive hemorrhage (for which most couching operations seem to have their chief value) because secondary bleeding is known to follow excision of the iris.[54]

Holmes Spicer[55] also gives an account of a successful couching by means of a Scarpa's needle passed through the sclera behind the ciliary body. The (one-eyed) patient was able to resume his occupation.

THE ARTIFICIAL RIPENING OF CATARACT.

Forms of Cataract Amenable to this Form of Operation.

The artificial ripening of cataract is of questionable benefit when applied to all types of lens opacities and when resorted to, should be confined exclusively to the cortical form, beginning between the fortieth and sixtieth years. In young subjects when the nucleus is as yet very

[52] Willburg. *Betrachtung über die bisherigen gewöhnlichen Operationen des Staares.* Nürnberg, 1785.

[53] Axenfeld. Sklerocornealer Starstich (Skleronyxis anterior) nach vorausgeschickter Iridektomie, *Bericht der Oph. Gesellschaft*, 1907, p. 116.

[54] See Pfluger's discussion of Bourgeois' paper before the *Soc. franc. d'ophtal.*, 1902.

[55] Spicer. Case of Couching of the Lens. *The Ophthalmic Review*, April, 1906, p. 122.

small, or non-existent, a discission is quite enough to hasten the process. In senile cataracts, a sharp distinction should be made between those affecting mainly the cortex and an undue hardening and increase of the nucleus.

The simplest classification of the different types of cataracts is the one founded on a structural basis, viz.: *nuclear, cortical* and *capsular.* All forms of cataracts involve one or more of these structures. The greatest number begin in the cortex as opaque striæ at the periphery and gradually involve the entire lens. When the process is complete, transmitted light thrown with the ophthalmoscope in the eye, gives no fundus reflex and oblique illumination casts no shadow of the iris on the lens. The patient has light perception but if the projection is good the lens is "ripe" and suitable for extraction. However, to apply this standard of "ripeness" to all forms of senile cataracts would lead to serious error, either in advising patients half blind from sclerosis of the lens to await an indefinite number of years for the cataract to become ripe, or to attempt artificial ripening in such a case.

The *nucleus* increases in size with age; even at forty it is an appreciable factor to be considered in cataract extraction. Between fifty and sixty it usually forms the major part of the lens, and later in life it forms no small part of a cataract even when the entire body becomes sclerosed. Here, the usual standard of ripeness fails utterly. Transmitted light in many nuclear cataracts gives a pronounced reflex from the fundus. A shadow from the iris is cast on the lens by oblique illumination and shows a gray or brown-yellowish opacity deep in the lens. This condition of affairs is in marked contrast to the brilliant fundus reflex often obtained with the ophthalmoscope.

The standard of ripeness for a sclerosed lens should be the inability to transact ordinary affairs, or the necessity of holding fair-sized type within a few inches of the eye.

On the whole, the sclerosed lens can be extracted more completely than the cortical variety which is so apt to leave some unexpelled lens matter to cause future trouble.

In the past most surgeons had an undue dread of attempting to remove an immature cataract, but at the present time the majority do not hesitate to extract as soon as the amount of vision does not come up to the patient's actual needs.

McKeown[56] showed that immature cataracts could be safely removed. He was the first to advocate washing hard, cataractous masses out of the anterior chamber with a stream of warm normal salt solution.

---

[56]McKeown. *Unripe Cataract*, London, 1898.

Various methods have been advocated for the artificial ripening of cataract and at one time they were extensively employed.

Muter[57] was the first to advise an operative procedure for the artificial ripening of cataract, his plan being laceration of the anterior capsule. He was followed later by von Graefe and other surgeons, but the writings of Förster on artificial ripening awakened most interest and he had a host of followers.

Operations for Ripening Cataract.

Among the principal methods employed for the artificial maturation of cataract are the following: (a) Paracentesis (T. R. Pooley); (b) Paracentesis with massage of the cornea (J. A. White; (c) Paracentesis with massage of the anterior capsule; (d) Division of the

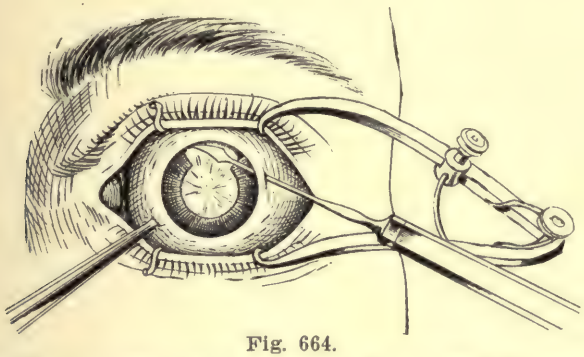


Fig. 664.

Reclination (Scleronyxis Anterior) with Preliminary Iridectomy. (After Axenfeld.)

anterior capsule; (e) Division of the anterior capsule with corneal massage; (f) Iridectomy with division of the anterior capsule (Mooren); (g) Iridectomy with massage of the cornea (Förster); (h) Iridectomy with division of the anterior capsule; (i) Intra-capsular injection of normal salt solution (temperature of 100° F.) with a special syringe (McKeown).

Förster's Operation for the Ripening of Immature Cataract.

Förster[58] believed that the sudden emptying of the anterior chamber and the subsequent rapid change in the shape of the lens would, by a kind of rubbing together of their already partially disorganized fibers, bring about a further opacification of the tissues. He, however, did not rely upon this agent alone but, in his artificial ripening operation, *after*

[57]Muter. *Practical Observations of Various Novel Methods of Operating on Cataracts.* London, 1813.

[58]Förster Ueber künstliche Reifung des Stars. Korelysis. *Bericht der Oph. Gesell.*, 1881, p. 133. Also see Ueber Reife des Stars, Kunstliche Reifung desselben, Korelysis, *Archiv. f. Augenheilk.*, 1833, p. 3.

an iridectomy, firmly stroked the cornea with a strabismus hook for 2 or 3 minutes. There can be no doubt but that this massage of the lens through the cornea is effective in many cases. Förster and others have reported many instances where six or eight weeks after corneal massage the immature cataract was found to be quite ready for extraction. Pagenstecher used a glass rod instead of the strabismus hook for making the massage. In any event, after either an iridectomy or a paracentesis the well-cocainized eye should be steadied with fixation forceps and the massage instrument employed to stroke firmly, regularly and slowly, in both radial and circular directions, the whole cornea. The time occupied should not exceed three minutes. As Förster pointed out, the main difficulty of the proceeding is the proper amount of force to be applied to the cornea; if it is too great the zonula of Zinn may be torn and the subsequent extraction be followed by extreme loss of vitreous. If the massage is too gentle the effect is nil, the lenticular fibers not being disturbed by the massage.

In American literature one finds a number of writers who have reported their experience of various ripening operations. Among these are Noyes[59] and Mittendorf,[60] who report their experience of Förster's plan of trituration of the lens; the former rather favorably, but the latter has seen iritis follow the procedure and thinks it a dangerous plan. Jackson[61] modified the Förster method by employing *indirect massage of the lens with the upper lid,* after emptying the anterior chamber. Boerne Bettman[62] was probably the first to introduce a spatula into the anterior chamber and apply "direct" massage to the anterior capsule.

It is questionable if any of these various methods is necessary. When one has to deal with an immature cataract one should perform a preliminary iridectomy some six weeks prior to the extraction, which generally aids in making the cortex more opaque. Following this, at the time of extraction, the corneal section should be made a trifle larger than the usual two-fifths of the limbus, and the capsulotomy should include one-third of the lens periphery. After the expression of the nucleus and opaque part of the cortex, the *free use of a warm normal, salt solution injected into the anterior chamber and capsule* with a suitable syringe, so as to wash out as much as possible of the *unexpelled lens*

[59]Noyes. On Förster's Operation for Ripening Immature Cataract. *Medical Record,* 1883, p. 118.

[60]Mittendorf. On Förster's Method of Artificially Ripening Cataracts. *Medical Record,* 1883, p. 717.

[61]Jackson. Indirect Massage of the Lens for the Artificial Ripening of Cataract. *Trans. Am. Oph. Soc.,* 1893, p. 623.

[62]Bettman. Artificial Ripening of Cataracts. *Jour. Am. Med. Assocn.,* Dec. 3, 1887. Also Ripening of Immature Cataracts by Direct Trituration. *Annals of Ophthalm.,* 1893, p. 26.

matter will be found very satisfactory. For this purpose we use at the New York Eye and Ear Infirmary a round, soft, rubber bulb with a diameter of 50 mm., having a capacity of two and a quarter ounces. To this is attached a glass tube 55 mm. long, and having the diameter of an ordinary eye dropper. Towards the end it tapers at an angle of 140°, is contracted at the mouth and flattened, having an opening 1 mm. broad. (See figure).

An iridectomy preliminary to any form of cataract extraction en-

Fig. 665.
Anterior Chamber Irrigator for Use in the Extraction of Immature Cataract.

Fig. 666.
The Simple Anterior Chamber Irrigator Ready for Use in the Extraction of Immature Cataract.

ables the operator to remove leisurely and more accurately a definite amount of the iris. Besides this advantage at the time of extraction, there is less liability of the iris falling over the cutting edge of the knife. This makes the extraction safer and easier, enables the surgeon to estimate the condition of the cataract itself, and indicates how the patient is likely to act during the remaining steps of the operation.

CHAPTER XI.

OPERATIONS FOR AFTER-CATARACT.

By MYLES STANDISH, M. D.. Boston, Mass.

Definition—Dangers of Operation for After-cataract—Varieties of Simple After-cataract—Complicated After-cataract—Object of Operations for After-cataract—Difficulties of these Operations—Simple After-cataract—Operations for the Simple Form of Secondary Cataract—Best time for Operation—Study of the Field of Operation—Cutting Instruments used in these Operations—Knives Employed in After-cataract Operations—Point of Entrance of the Needle in Discission—Operation in Simple After-cataract by a Single Incision—The Advantages of a Dark Operating Room—Preparations for Operating—Technique of the Single Incision Operation—Discission with Post's Knife-needle—Discission with the Graefe Cataract Knife—Secondary Operation with Weeks' Knife-needle—Operations on Simple After-cataract by more than one Incision—Discission with Ziegler's Knife—Bowman's Operation for Simple After-cataract—Avulsion of the After-cataract—Complicated After-cataract—Iridotomy Operations with Simple Incision—Adams' Operation for Closed Pupil and Secondary Cataract—Kuhnt's Operation for Secondary Cataract—Iridocystectomy in Closed Pupil—Iridotomy by Ziegler's Method—Operations for Complicated Cataract by the use of Scissors—Operation with de Wecker's Scissors—Operation with Ferguson's Scissors—Operation with Noyes' Scissors—Punches for making Openings in After-cataract—Hemorrhage—After-care.

Definition.

An after-cataract is any membrane stretched across the area of the pupil after a cataract extraction, which obscures vision.

These opacities vary from a loose, clear capsule which, hanging in folds, disperses light and obscures vision, to a dense, inflammatory membrane on which is superimposed the iris, the lower pupillary border of which may be drawn up into, or into the neighborhood of the cicatrix resulting from the incision in the cornea made for the extraction of the cataractous lens.

The Dangers of Operation for After-Cataract.

Much has been written about the dangers of operation on after-cataract, and even at the present time many surgeons never operate unless it is absolutely necessary, to secure useful vision. Much of

this dread has come down to us from pre-aseptic times. Iritis was then a much more common complication during convalescence from cataract extraction, and the resulting cyclitis produced a condition which was easily aggravated by any subsequent operation. The preceding iridocyclitis also produced a matting together of the tissues at the root of the iris which increased the predisposition of such eyes to a glaucomatous cyclitis. Septic infection at the point of incision in the operation for after-cataract was also a much more common accident. At the present time these dangers are much less than formerly and some operators, notably Knapp,[1] have advocated the use of the method in every case in which vision could be distinctly increased. But that there is real danger is evidenced by Marshall's[2] report during the five years from 1889 to 1893. During this period there were 404 operations for after-cataract in which number there were five cases of suppuration and ten cases of glaucoma giving 1.02 per cent. cases of suppuration and 2.08 per cent. of glaucoma. His explanation of the method of infection is that when the needle is withdrawn a tag of capsule, or vitreous, may follow it up to the corneal puncture and even be drawn through it and project exteriorly, which affords a very ready means of infection of the interior of the globe. When a percentage as high as this is reported by so eminent an authority, it is obvious that aseptic precautions should be as thoroughly observed in every case of after-cataract as in the original operation.

Varieties of Simple After-Cataract.

The simplest form of after-cataract is that in which the loose posterior capsule throws itself into folds or ridges upon which are minute dots. This membrane will often produce an amount of obstruction to the vision entirely out of proportion to its apparent opacity, as seen when looking into the eye with the ophthalmoscope. The reduction of vision is due to the dispersal of the rays of light by the corrugations of the membrane.

The next and more serious condition is that in which the obstruction is due to opaque masses or bands of tissue lying upon the anterior surface of the capsule. These arise from a variety of causes, being largely due to the fact that the epithelial lining of the posterior capsule which produces the lenticular fibres continues under the new conditions to produce abortive lenticular cells. This is especially true where the anterior capsule overlies the posterior capsule, these cells subsequently becoming sclerosed and opaque.

---

[1]Knapp. Operations for Secondary Cataract. *Trans. Amer. Oph. Soc.*, 1898, p. 297.

[2]Marshall. Immediate and Remote Results of Cataract Extraction. *Royal Lon. Oph. Hosp. Reports*, Vol. XIV, p. 56.

Another frequent source of after-cataract is small masses of cortical lens-matter that remain behind when the lens is extracted. These subsequently undergo absorption but at their seat there is found a dense connective-tissue-like material. Bates[3] from experimental work upon rabbits drew the conclusion that the fluid which replaced the normal aqueous humor not only contained albumin, but would clot, and that such clots when stained and examined by the microscope showed the structure to be of fibrin. He deduced from these experiments that probably a fibrinous connective tissue process followed on the capsule from loss of the aqueous humor during cataract extraction. It is well known that when the wound of a cataract extraction does not close promptly, so that there is a considerable leakage of aqueous for a number of days, these opacities on the posterior capsule are much more likely to occur. This fact would seem to confirm Bates' deductions.

These opacities very often take the form of bands stretching across the pupil in a direction approaching vertical. The capsule itself is elastic, and these bands tend to contract and draw the elastic membrane tensely across the area of the pupil.

Another variety of simple after-cataract is due to former disease of the capsule itself, in cases of old and complicated cataract.

Complicated After-Cataract.

When, following cataract extraction, we have an iritis or an iridocyclitis, the result complicates the simple after-cataract by pouring out upon the surface of the capsule an exudate from the iris. This exudate forms dense opaque masses at the border of the pupil, gluing it to the capsule at such places, and if the iritis has been profound the whole margin of the iris may in this manner be agglutinated to the capsule. The pupillary area becomes much diminished, and if the iritis is complicated with ciliary inflammation in the neighborhood of the original wound, the iris may be drawn up and attached by inflammatory material in such a manner that the lower border of the pupil is dragged to the upper margin of the anterior chamber. The consequent stretching of the iris tissue approximates it to the capsule to which it becomes firmly adherent, with the result that a dense, inflammatory membrane of iris tissue, connective tissue and posterior capsule is stretched across the anterior chamber.

Object of Operations for After-Cataract.

The intent of the operation is to obtain a clear opening in the pupil for the purpose of giving distinct vision. In a simple after-cataract the size of the opening is of less importance than its posi-

[3]Bates. *N. Y. Medical Journal*, July 7, 1900.

tion. A very small opening in a fairly transparent capsule often gives as good, or better, vision than a large one, provided this opening is centrally placed. Most operators have laid stress on the statement that the important factor is a wide horizontal slit. It is probable that too much stress has been laid upon this point and that a vertical slit giving a clear area through which the lower part of the field of vision is clear is even more useful than a wider opening whose main dimension is horizontal.

Difficulties Attending Operations for After-Cataract.

The principal difficulty encountered in this operation is often the inability of the operator to see exactly what he is doing. This is chiefly due to alterations in the illumination and the refraction of the light. First, after the needle is introduced into the anterior chamber a slight amount of traction on the cornea is produced by the movements of the needle, which alters the curvature of the cornea. Second, while the membrane may be perfectly distinct as it is stretched across the posterior portion of the anterior chamber, the moment the point and cutting edge of the needle depresses the center of the membrane, the reflection of the light from its surface is thrown in such a manner as to make it quite, or almost, invisible. Jackson[4] urges that every operator should use a binocular magnifier, and while his advice has not been generally followed, it serves to emphasize this particular difficulty in the operation.

Most operators have agreed that it is necessary in these operations to avoid traction upon the ciliary body through the attachment of the posterior capsule. The chief difficulty that this presents is due to the fact that it is only with the greatest care that the small knife-needles used in the operation can be made and kept sufficiently sharp to do their work without dragging on the capsule during a discission.

Dangers of the Operation for Secondary Cataract.

Infection of the corneal wound is often due to the fact that insufficient precautions have been taken before the operation. But many operators believe that the point of incision is of importance in this respect, and if the needle be entered well back at the limbus, or even subconjunctivally, and then through the limbus into the anterior chamber, the vascular blood supply of this region is a safeguard against infection.

The second danger is that the *traction on the after-cataract* may be sufficient to produce a recurrence of an iridocyclitis, and that this inflammation may pursue a very slow, inactive course with the loss

[4]Jackson. *Archiv. of Ophthal.*, Vol. XXXV, 1906, p. 127.

of the physiological function of the ciliary body weeks or months afterwards, with consequent loss of vision.

The third danger is that if there has been much inflammatory exudate poured out upon the capsule, this may send out proliferations which may subsequently close the opening made by operation.

Most of the early operations for after-cataract were designed for use in those cases in which the pupil had become occluded by inflammatory products, but in recent years operations are also done for after-cataracts which are much less formidable, and the great bulk of operations for after-cataract at the present time are upon the posterior capsule on which opaque masses have appeared. These vary widely in their translucency, from the simplest form, in which the posterior capsule of the lens is hanging loosely in folds upon which are deposited minute points of opacity, through the various grades in which these opacities occur in larger areas, and not infrequently in the form of opaque striæ, or bands approximately vertical, to those cases still more troublesome in which in addition to areas and bands of opacity on the capsule, there are points of attachment to the iris, opposite which masses of opaque material have extended onto the capsule.

OPERATIONS FOR SIMPLE AFTER-CATARACT.

Time of Election for Operation.

When it is expedient and proper to operate for simple after-cataract has been much discussed. Knapp[5] who stated, "I perform extractions with a view towards the necessity of a subsequent discission," naturally operated earlier than others who fear the results of secondary operations. It is his custom to operate within a few weeks after the extraction in cases of simple after-cataract. Surgeons who have never performed the operations, except in cases where the vision is very greatly obscured, operate, as a rule, upon more complicated after-cataracts that have been the subject of an iridocyclitis, and have naturally maintained that early operations are inadvisable. Success under these circumstances is absolutely dependent upon the entire subsidence of the original inflammation, and even then sufficient time must be allowed for the circulatory apparatus of the eye to recover its normal function so completely that even the slight traumatism produced by the operation is not sufficient to cause a recurrence of the inflammatory process. Obviously, in these cases, a considerable period of time must elapse before the secondary operation is undertaken. Careful operators often wait three or four

[5] Norris and Oliver. *System of Diseases of the Eye*, p. 816.

months before again exposing the eye to the traumatism of an operation.

When an operation for after-cataract is performed soon after the extraction of the lens, there is danger that the tension caused by pressure of the needle in one direction, and the pulling caused by the fixation forceps in the opposite direction, may be sufficient to reopen the original wound, therefore the prompt healing of the wound with a flat and firm cicatrix is a condition precedent to an early secondary operation for after-cataract.

Study of the Field of Operation.

Before operation study the area of the capsule when the pupil is undilated. This is necessary to make sure that the opening in the capsule resulting from the operation shall be exactly in the center of the pupil. The danger in operating upon a membrane with a dilated pupil is that, owing to some inelasticity of the iris on one side, or because it is adherent to the capsule, the operator may select the center of the capsule as exposed, and when the mydriatic is omitted he finds to his chagrin that the opening is at one side of the pupil, or, in extreme cases, even behind the iris. Another reason for this preliminary study is that the elasticity of the capsule often allows it to be pushed before the blade of the knife and the opening is then made a considerable distance from the true center of the pupil in which the operator thinks he is operating.

In this preliminary study it is necessary to do two things. First, locate the center of the pupil by means of the relationship of such opacities as appear upon the capsule, so that it is easily recognized after the pupil is dilated. Second, observe whether the capsule is stretched more tautly in one direction than in others, so that advantage of this tension may be taken in making the incision and the opening remain widely extended.

Cutting Instruments Used in the Operation.

Cutting instruments used in these operations are knife-needles, knives, scissors, spear-pointed needles and punches.

The operation for simple after-cataract at the present time is more often done with some form of knife than by any other instrument.

The first requisite of a *knife-needle* for after-cataract discission is that *it should be very sharp*. This is a condition of the instrument not easily obtained and maintained, owing to the mechanical difficulties of sharpening the instrument, and the care necessary to keep it sharp during the aseptic preparation and the subsequent manipula-

tions. If such a blade is drawn only once or twice across a piece of the finest linen the cutting edge is practically destroyed.

Secondly, the blade should make an opening in the cornea no larger than is entirely filled by the shank of the instrument. This is necessary to prevent the evacuation of the aqueous early in the operation and to avoid an advance of the vitreous and its inevitable wide laceration during the maneuvers to cut the after-cataract.

The third requisite of a proper knife-needle is that the cutting edge shall be so placed that it will incise the membrane when it is drawn back and forth upon its surface, or, if entered more obliquely, that the edge shall cut without wide excursions into the vitreous, in

Fig. 667.
Cheselden's Knife-Needle. (After Sharp.)

the sawing movement which is necessary to do these operations, and without undue tension upon the ciliary attachment of the capsule.

The fourth requisite is that if the point is to be used in puncturing the membrane, it shall be sufficiently sharp and thin to puncture it easily, without pushing the capsule before the blade.

Knives Used in After-Cataract Operations.

The first knife for secondary cataract was described by William Cheselden.[6] It consisted of a long narrow shank with a knife blade at the end 11 mm. in length, and was used by making a puncture through the anterior portion of the sclera and approaching the membrane of the after-cataract from the posterior chamber. Ziegler[7]

Fig. 668.
Hays' Knife-Needle.

draws attention to the fact that it was very similar to Hays' knife-needle, which was used by Isaac Hays[8] in his surgical work at the Wills' Eye Hospital and has been in constant use by the staff of that institution for half a century. It was described by the inventor as follows: "This instrument from the point to the head near the handle is six-tenths of an inch, its cutting edge nearly four-tenths of an inch. The back is straight to near the point where it is truncated so as to make the point stronger, but at the same time leave it very acute.

[6]Cheselden. *Philosophical Transactions*, London, 1728, Vol. XXXV, p. 454.
[7]Ziegler. History of Iridotomy. *Jour. Am. Med. Assocn.*, 1908.
[8]Hays. *American Journal Medical Sciences*, July, 1855, p. 82.

The edge of this truncated portion is made to cut. The remainder of the back is simply rounded off. The cutting edge is perfectly straight and is made to cut up to the part where the instrument becomes round. This portion requires to be carefully constructed so that as the instrument enters the eye, it shall fill up the incision and thus prevent the escape of aqueous humor."

Ziegler[9] has described a knife-needle as follows: "The form of this needle is the falciform knife and the bistoury and possesses the advantages of both. It has a delicate point which punctures easily and an excellent cutting edge of sufficient length (7 mm.) and if the shank is properly rounded it can be used with a sawing motion, slid-

Fig. 669.
Ziegler's Knife-Needle.

ing backwards and forwards through the corneal puncture without injuring the cornea and without allowing the escape of aqueous."

Knapp designed a knife-needle which has been much used and consists of a narrow shank with the point opposite to the center of the shaft and the cutting edge somewhat bellied. The blade is 5 mm. long.

Sichel's iridotome is very similar to Knapp's knife-needle with the exception that the rounded back of the blade is straight and the blade is 11 mm. in length.

The falciform knife which Graefe recommends and Galezowski employs has a straight blade with a slight falciform point.

Fig. 670.
Knapp's Knife-Needle.

Risley[10] described a knife which he designed, and drew attention to the fact that a cross section through most knife-needles presents too often an almost equilateral triangle which he avoids by having a spear-shaped knife, sharp at both edges, beaten out on the end of the shank. The midrib of the spear is very thin and tapers gradually to the point and to either edge. The amount of metal in the spear or blade of the knife is the same as contained in the shank, less the loss sustained in grinding and polishing. He thought the advantage of such an instrument was that it could be readily and satisfactorily

[9]Ziegler. History of Iridotomy. Knife-Needle vs. Scissors. *Trans. Sec. Oph. A. M. A.*, 1908, p. 372.
[10]Risley. *Trans. Amer. Oph. Soc.*, 1895, p. 402.

sharpened from the fact that a cross section through the blade is not a triangle, but a very flat ellipse.

Post[11] described a knife-needle which he designed, as follows: "The blade is 6 mm. long and 1¼ mm. wide at its widest part. It has a back straight and dull and a rounded cutting edge extending its entire length. The shank is cylindrical and of a diameter sufficient to prevent the escape of aqueous during the operation. The width of the blade is sufficient to admit of its cutting edge being ground very sharp."

Weeks[12] devised a curved knife-needle shaped something like a sickle, the length of the blade varying from 5 to 3½ mm. A hooked extremity is formed by a curve which extends from the middle of the

Fig. 671.
Falciform Knife-Needle.

blade to its point. The curve of the blade brings the extreme point 2.5 mm. away from a line projected from the axis of the shaft. The blade is about 2/3 mm. wide and the shaft is just large enough to fill the opening made by the blade. The concave edge and point of the blade are made as sharp as possible, and the convex edge, to a point 1 mm. up, is also sharpened.

Levinsohn[13] described a similar curved knife-needle.

Point of Entrance of the Needle in Discission.

There has been much controversy for over 100 years as to the proper place to pierce the globe on making an incision in an after-cataract. Cheselden,[14] whose knife has been described, made his puncture back of the sclero-corneal junction on the temporal side

Fig. 672.
Post's Knife-Needle.

behind the iris, carried the knife across the posterior chamber, and cut through the iris from behind forward. In recent years Da Gama Pinto[15] entered his knife still farther back, from 6 to 8 mm. from the sclero-corneal junction. The point was then carried back to-

[11]Post. *Amer. Jour. Oph.*, Vol. XXV, p. 129.
[12]Weeks. Discission of the Capsule After Cataract Extraction, with the Presentation of a New Instrument. *Trans. Amer. Oph. Soc.*, 1895, p. 398.
[13]Levinsohn. Ueber ein einfaches und Sicheres Verfahren der Nachstardiszission. *Klin. Monatsbl. für Augenheil*, 1909, p. 297.
[14]Cheselden. *Philosophical Transactions, London*, 1728, Vol. XXXV, p. 451.
[15]Da Gama Pinto. *Ann. d'Oculistique*, 1897.

ward the center of the globe, but after it was entered he brought it gradually forward so as to transfix the after-cataract near the pupillary margin of the same side from behind forward. He then pushed the knife forward across the anterior surface of the membrane to the opposite side of the pupil and subsequently withdrew the knife by the reversal of the procedure from entering the globe.

Da Gama Pinto at the Luzerne Congress in 1904, stated that he had abandoned the operation because he had observed two cases of detachment of the retina after the procedure. With these exceptions all operators have entered the knife either anterior to, or at the sclero-corneal margin. That the point of entrance should be at or near the limbus of the cornea has been insisted upon by many opera-

Fig. 673.
Weeks' Knife-Needle.

tors. One of the principal advantages of the peripheric puncture lies in the fact that with the blade of the knife introduced parallel to the plane of the iris, the curve of the cornea forms a valve-like opening which is closed, upon the withdrawal of the knife, by intraocular pressure. Many operators believe that, owing to the great vascularity of the limbus, there is much less danger of infection in making the wound at that point, and others have thought that they obtained still greater safety from infection by drawing forward the conjunctiva and entering the knife through that, thence passing it through the limbus into the anterior chamber. These advantages of a peripheric incision have been strongly urged by many operators,

Fig. 674.
Risley's Knife-Needle.

and Jackson[16] emphasizes the necessity of this method of entrance to the anterior chamber and unqualifiedly condemns all other methods. He gives as one of the reasons that one can obtain with a peripheral puncture a sweep of 8 mm., while with a corneal puncture he can get only a sweep of 4 mm.

As all incisions in the after-cataract must be made with a sawing motion, the length of the portion of the blade which is cutting at a given time must be greater with a very oblique position of the knife, and the penetration of the vitreous is apt to be less than if the knife approaches the after-cataract more perpendicularly.

[16]**Jackson.** ***Archives of Ophthal.*****, 1906, p. 127.**

The loss of the aqueous from the anterior chamber previous to the incision in the after-cataract greatly increases the extent of laceration of the vitreous and the difficulties of the operation. The dangers of infection from a puncture of the cornea anterior to the limbus, under proper aseptic precautions, have been greatly exaggerated, and it may often happen in a given case that the position of the opacities in the capsule may make the probabilities of success much greater when the knife is entered more anteriorly.

When the incision is made in the clear cornea, the knife should still be entered in such a manner as to make a valve-like incision in order to prevent the loss of the aqueous upon the withdrawal of the knife, which always happens if the knife is thrust perpendicularly through the cornea directly towards the after-cataract. These essentials in the entrance of the knife are equally valuable whatever form of instrument is used.

Operation by a Single Incision in Simple After-Cataract.

The dangers of non-success from a single incision in simple after-cataract are two: First, that the wound may not open widely enough to give good vision, and, second, that the opening may subsequently close as the result of a low, inflammatory process.

The precautions necessary to avoid failure are, first, to make the incision transverse to the principal line of tension in order that the opening may be broadened by the release of this tension; and, second, not to do an early operation in a case in which there has been a considerable inflammatory process following the extraction.

The direction of the incision should be carefully selected. McGillivray,[17] who used a knife not unlike that described by Post, stated that the preferable incision in the capsule was one running diagonally across the whole extent of the dilated pupillary area, from above downwards and inwards, and, other things being equal, such an incision undoubtedly has great practical advantages, nevertheless, a small vertical incision centrally placed in the pupil in a not very opaque capsule, will often give the highest possible vision, even when its length is not more than 2 or 3 mm.

The horizontal incision has undoubtedly been used by more operators than any other in operations for after-cataract. Its principal advantage is ease of technique.

The Advantages of Operating in a Dark Room.

A brilliant illumination of the after-cataract is absolutely necessary for successful operation. This can never be obtained while

[17] McGillivray. The Treatment of "After-Cataract." *Trans. Oph. Soc., U. K.*, 1907, p. 108.

operating in diffuse daylight. The dispersal of the rays of light by a slight change in the curvature of the cornea, due to pressue of the knife, will often make an after-cataract, which is entirely visible before the operation is begun, quite invisible at the moment of the incision. Often again, the after-cataract is depressed by the point of the knife in such a manner that its visibility is entirely lost. This condition will be obviated by focal illumination, and for many years operators have had light focalized upon the after-cataract by means of a hand lens held by an assistant. This method, although pursued in a dark room with a single light is often unsatisfactory because the operator may have very annoying reflections between himself and the point of operation, when the field is perfectly illuminated from the point of view of the assistant holding the focalizing lens. A much better method is to illuminate the anterior chamber by a small, shaded electric light, but when this is held by an assistant, not infrequently the operator does not have the best point of view.

To obviate this annoyance Chandler[18] devised a small electric light enclosed in a shield with a focalizing lens in front. This instrument was attached to the forceps with which the eye was held, thus placing the control of the illumination entirely within the hands of the operating surgeon. He suggested that it could also be used upon the knife-needle, and recently I have had my knife-needle blades constructed without handles and use them in the electrically illuminated spud handle. This can be so arranged that the condensation of the light through the small lens in front of it can be brought exactly to bear upon the cutting portion of the needle, and therefore the illumination is always perfect. Small lights have also been devised which can be attached to the handle of any knife-needle, which would seem to be a desirable arrangement.

Preparations for Operating on After-Cataract.

First, see that aseptic precautions are as thoroughly followed out as for an extraction of the lens. Second, study the after-cataract with undilated pupil. Locate by landmarks the portion of the after-cataract which is central. Determine, if possible, lines of tension, and whether the elasticity or tension of the membrane is such as to make probable a successful opening after a single incision. Third, determine whether in a given case it is desirable to use a straight-pointed knife, a sickle-shaped knife or a curved knife; or a full-bellied knife which cuts without preliminary puncture with the point. This choice will be largely governed by the amount and direction of the dense opacities in the capsule, and the tension of the globe. Alternate areas of thin capsule and dense bands are perhaps more easily incised

[18]Chandler. Capsular Cataract. *Ophthalmic Record*, Sept., 1899., p. 447.

with a knife which has some form of falciform point and a considerable length of cutting blade. Less dense capsules, especially when present in rather soft eyes, or eyes known to have fluid, or semi-fluid vitreous, are more easily cut with a knife which has considerable belly to the cutting edge. Fourth, measure the length of the cutting blade of the needle over the area to be operated on and be sure that its edge is of sufficient length, and see that the knife is sharp. Fifth, dilate the pupil with atropine before the operation. Sixth, darken the room and see that the electric illumination is in good working order and trustworthy.

Technique of Operation Upon Simple After-Cataract by Single Incision.

The eye having been cocainized, a speculum is introduced which opens the lids without great pressure. The conjunctival and episcleral tissues are seized by fixation forceps opposite to the point of puncture. This point should be selected so that the cut in the after-cataract can be easily made along the line decided upon. The knife blade, being held parallel to the plane of the iris, is thrust through the cornea at the point selected, preferably at the limbus, thence it is carried directly across the anterior chamber to a point a millimeter or two beyond that where it is necessary to make the counter-puncture. The edge of the blade is then turned toward the membrane, and thrust through the after-cataract within a previously determined, *thin* area. Then the knife should be drawn back and forth across the line of incision, making as little pressure as possible to achieve the object and absolutely avoiding any prying motion which uses the cornea as a fulcrum as this procedure tends to evacuate the anterior chamber and produce strain upon the ciliary attachment of the capsule. It often happens that after the counter puncture has been made with the point of the knife the elastic capsule recedes before the knife, which does not cut. In this event, the sawing motion must be persisted in until it is obvious that the method will not succeed. Under these circumstances it is wise to depress the point of the knife so as to produce the maximum of cutting across the thickness of the capsule without tearing or dragging its way through the membrane. Upon the conclusion of the incision the knife blade is turned to its original position, the handle is carefully placed in the plane of the iris and the knife is withdrawn. If this is done skillfully there ought to be a minimum loss of the aqueous, intraocular pressure promptly closing the wound.

Discission with Post's Knife-Needle.

Post[19] describes the method of using his knife-needle as follows:

[19] Post. *Amer. Jour. of Oph.*, 1908, p. 130.

"The point is entered near the periphery of the cornea with the flat of the blade parallel to the plane of the iris and is carried well across the pupil to the place where it is proposed to pass it through the membrane. The blade now cuts its way to an extent equal to its own width. Having passed it still farther it is pressed in the direction of the cutting edge so that in withdrawing it, the sharp heel of the blade divides the membrane as far as may be necessary."

Discission with the Graefe Cataract Knife.

Many operators have used an exceedingly narrow, but stiff cataract knife to make the incision above described. The disadvantage of this instrument is that in making the sawing motion necessary to cut the capsule, the operator has his attention drawn away from the cor-

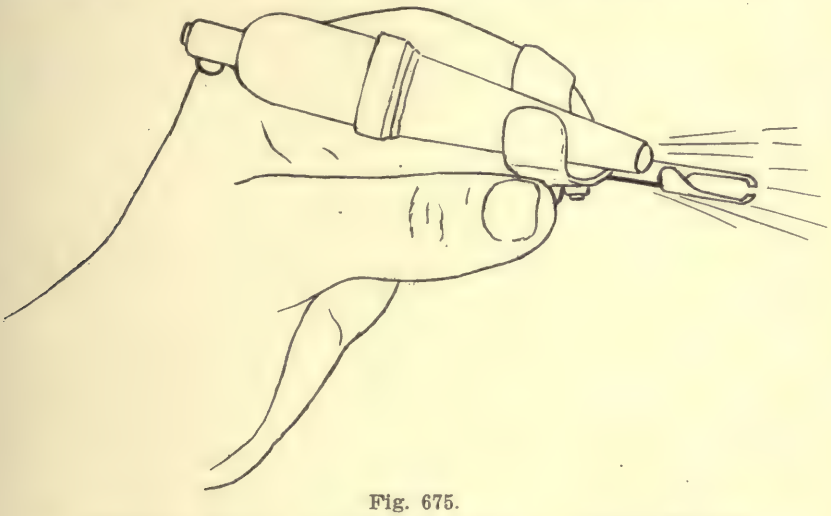


Fig. 675.
Chandler's Electric Illuminator Attached to Fixation Forceps.

neal incision and is apt to enlarge the corneal incision during the operation with consequent loss of aqueous. This loss of aqueous is followed by the pushing forward of the vitreous, and makes the second incision, if such is necessary, exceedingly difficult, while considerable laceration of the vitreous is inevitable. Some surgeons dull the edge of the cataract knife from the heel almost to the point for the purpose of avoiding this enlargement of the incision, but a capsulotomy with a Graefe knife by any method is rarely done without losing practically all the aqueous.

Secondary Operation with Weeks' Knife-Needle.

In this operation[29] the passage of the knife into the anterior

[29]Weeks. Loco cit.

chamber is not so easily effected as with the Knapp knife-needle. The operator should stand behind the patient, using the right hand to operate on the right eye, and the left hand to operate on the left eye. The puncture is made in the cornea at a point in its horizontal meridian midway between the center and the periphery of the cornea on its temporal side. The curve of the knife must be followed in the passage through the cornea to avoid making an incision too large to be filled by the shaft. The knife is entered on the flat, the sharp edge toward the upper margin of the cornea. After entering the anterior chamber the point of the knife is passed to the opposite margin of the iris; it is then turned so that the cutting edge presents toward the capsule, and the point is made to pierce the capsule. The knife is so held during the time of making the incision that only the thickness of the capsule presents against its edge. The resistance is thus reduced to the lowest possible degree and the danger of destroying the membrane and of making too much traction on the ciliary body is avoided. It is seldom that this knife will divide successfully a tough capsule or firm bands without undue traction on the ciliary attach-

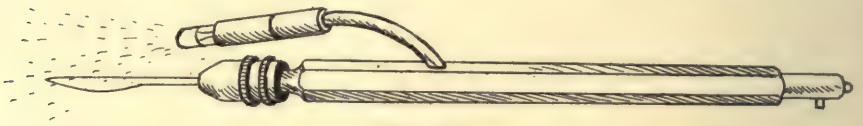


Fig. 676.
Electric Spud-handle Used as Illuminator for Knife-Needle.

ment of the membrane; it must be exceedingly sharp to divide even a thin membrane satisfactorily, and is difficult to remove from the eye if the patient becomes unruly. On withdrawing the knife it should be turned on the flat as when entered and the curve of the blade followed. Weeks thinks that on account of the dull convex edge of its curved extremity, the knife is much more easily manipulated, and that the vitreous is less liable to injury by this method.

OPERATIONS UPON SIMPLE AFTER-CATARACT BY MORE THAN ONE INCISION.

There are three methods of cutting the capsule with more than one incision, which have in common a dependence upon the elasticity of the capsule to curl back the tongues of the tissue which are included between the incisions.

The *first method* consists of two incisions which meet at their proximal ends and form a V. The point of entrance is selected in the lower margin of the cornea at a point which is determined by the position of the opacities and the line of tension in the capsule. The

knife, with the flat of the blade in the plane of the iris, is thrust through the cornea near or at the limbus, and carried across the pupillary area obliquely to its inner (or outer) upper margin. The cutting edge of the blade is then turned toward the capsule, the point thrust through the membrane and the incision extended to the inferior edge of the pupil by a sawing motion. The knife is then turned so that the blade is in the plane of the iris, and is carried forward to the upper margin of the pupil and swept across to the opposite side. Thence a second incision is made across the pupillary area to meet the first incision below, the two incisions forming the letter V. The difficulty in this operation consists in cutting the last portion of the second incision, because when the tissue between the two incisions becomes narrow its elasticity is greatly exaggerated and it is with con-

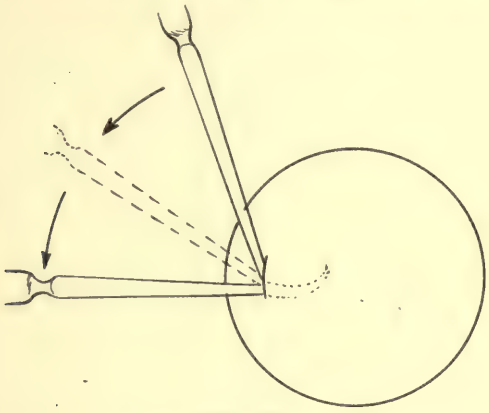


Fig. 677.

Sweep of Needle to Follow Curve When Piercing Cornea. (Weeks.)

siderable difficulty that the second incision is carried into the line of the first. This operation can also be done by entering the knife above the resulting incisions making an inverted letter Λ. Some operators however, prefer not to have the puncture at the site of the cicatrix resulting from the incision made in the operation for the extraction of the lens.

The *second method* is by a T-shaped incision. The puncture is the same as in the operation just described. An incision is made across the upper portion of the pupillary space, after which the blade is carried back to the center of the first incision and the second incision is made from that point to the lower margin of the pupil perpendicular to the line of the first incision. The difficulty with this method is that after the tension of the membrane has been relaxed by the first incision, the second is made with so much difficulty that the

pressure required to make the incision will depress the membrane and is apt to cause considerable laceration of the vitreous.

The *third method* of double discission is by a cross incision. In this operation the knife, having been entered as before, is carried to the center of the upper portion of the pupillary space, thence vertically down and an incision is then made from the margin of the pupil on either side to the incision already made.

Bowman's Operation for Simple After-Cataract.

The amount of traction made upon the ciliary body at the insertion of the capsule has been much dreaded by operators and in order to avoid it Bowman devised an operation which was formerly much practised. He used two spear-pointed stop-needles with sharp cutting edges. The eye being fixed with forceps, one of the needles is thrust through the tissues of the limbus at one end of the transverse

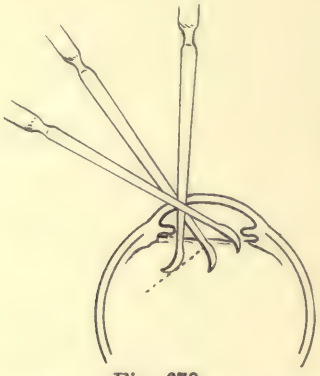


Fig. 678.
Contact with Capsule When Curved Needle is Employed. (Weeks).

diameter, the breadth of the spear-head point being parallel to the plane of the iris. Then, putting down the fixation forceps and steadying the eye with the needle already introduced, a second needle is introduced in the same manner through the limbus directly opposite the point of the incision of the first needle. Both points are then carried on until they reach the middle of the pupillary area. Both needles are then plunged through one opening in the capsule, being careful that no tissue intervenes between the blades of the needles. The needles are then turned so that their cutting edges lie in the transverse diameter and the handles of the needles are approximated. By this movement the membrane will be divided by the two needles. If this is insufficient, the needles are carried back to the first position, and second slits made at right angles to the first. The needles are then rotated so that their blades are in the same plane as when first

introduced and withdrawn. If skillfully done, there need be no loss of aqueous.

AVULSION OF THE AFTER-CATARACT.

Panas[22] recommended extraction of the after-cataract. He considered it necessary to wait a considerable number of months after the primary operation before attempting this procedure. He examined the eye very carefully to determine the presence or absence of adhesions between the membrane and the iris. If found, he divided the synechiæ by means of a narrow, curved knife. He made an incision 8 or 10 mm. long in the upper corneal margin and then, using special forceps, with the sharp blade backward, he passed them down into the anterior chamber, perforated the after-cataract with the sharp blade until the upper blade was in the lowest part of the anterior chamber. He then closed the forceps, grasping the tissues between the blades. In the withdrawal traction was made at first vertical, followed by slight lateral movements which broke down the small adhesions. The membrane generally came out whole, but occasionally it was held by a sort of pedicle at the upper part of the coloboma. This pedicle was cut off with the scissors and the prolapse reduced.

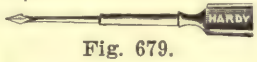


Fig. 679.
Bowman's Stop-Needle.

Major Smith[23] states that in his hands the removal of the posterior capsule has been eminently satisfactory. He does an iridectomy above, if it has not already been done, reaches in, somewhat beyond the center of the pupil, with a rather stout pair of iridectomy forceps, allows the blades to separate, drives them through the after-cataract wide apart, closes the forceps firmly and withdraws the after-cataract. He adds that there may be an escape of a bead of vitreous, but this he considers of no importance.

Partial avulsion has also been done by various surgeons in which the membrane was drawn out of the anterior chamber with a Tyrrell's hook and cut off.

In cases of a thick membrane with firm adhesions, Agnew performed an operation which is described by Noyes.[24] At the upper edge of the cornea a broad needle pierces the capsule and is held steady. At the opposite side, on the margin, a wound is made for the introduction into the anterior chamber of a small, sharp hook

[22]Panas. De L'intervention Opératoire dans les Cataractes Secondaires. *Archives d'Ophtal., Vol.* XXII, p. 549.
[23]Smith. *Archives of Ophthalm.*, 1906, p. 137.
[24]Noyes. *Diseases of the Eye*, p. 467.

whose point is engaged in the wound in the capsule made by the broad needle. Securing a good hold the hook tears down the membrane and is resisted by the needle in the operator's other hand, which also defends the ciliary region from traction. As much of the tissue is drawn out of the wound as possible. It is then cut off with scissors by an assistant.

COMPLICATED AFTER-CATARACT.

Complicated after-cataracts are always due to an iritis or an iridocyclitis following the extraction of the lens. This complication may be due either to traumatism at time of operation, or to irritation resulting from small fragments of the lens left after the extraction; to prolapse of the iris following an extraction either with or without

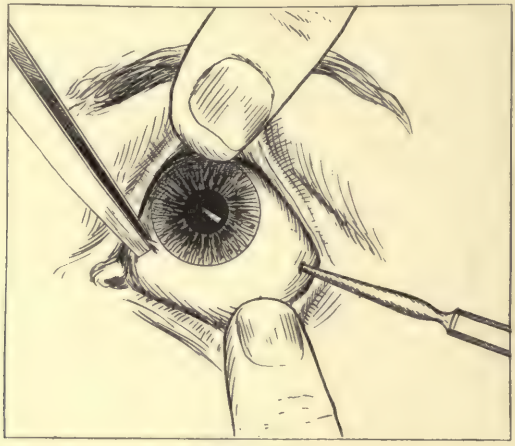


Fig. 680.
Entrance Through the Sclera for Division of After-Cataract. (Meller.)

iridectomy; to infection at time of operation, or it may have its origin in some constitutional condition, as syphilis, rheumatism, diabetes, or tuberculosis.

Whatever the etiology the result is a small pupil firmly tied down along the greater part of its margin, and a firm, dense membrane occupying the pupillary area.

A second condition is an incomplete prolapse of the iris, so that it, or the pillars of the coloboma (when an iridectomy has been done), become attached to the cicatrix of the incision made for the purpose of extracting the lens. In these cases the tendency is for the iris to become more and more firmly attached above, and as this progresses the iris tissue below the pupil is dragged up to the seat of the wound. Occasionally the lower margin of the pupil is attached

directly to the corneal cicatrix. Then the whole area visible through the cornea is occupied by the tightly stretched iris. Practically in all recent cases the slightest traumatism may produce a violent return of the cyclitis and nullify the operation. Consequently it is wise to postpone operation for a considerable period—three or four months—until all ciliary tenderness has disappeared and the eye has become white and quiet.

Iridotomy Operations With Single Incisions.

Early operations for complicated after-cataract consisted in making an incision horizontally through the membrane. Cheselden's

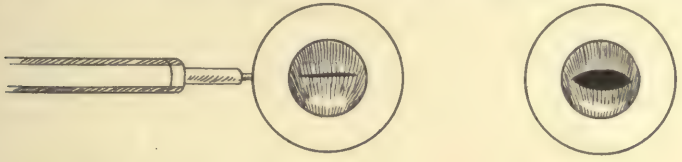


Fig. 681.
Adams' Operation and Resulting Opening. (After Lawrence).

original procedure was of that character. He entered his knife-needle through the sclera back of the sclero-corneal junction on the temporal side. He then passed his knife across the posterior chamber, made his counter-puncture in the iridic membrane near the nasal margin. He then cut through the iris from behind forward for two-thirds of its extent. This made a horizontal slit which resulted in a more or less oval opening, according to the elasticity of the membrane. The after result with this operation was apt to be much modified by traumatic iritis with consequent obliteration of the pupil, or by the formation of a membrane in the new pupil.

Fig. 682.
Adams' Iris Scalpel.

Adams' Operation for Closed Pupil and Secondary Cataract.

Adams[25] modified Cheselden's operation by using a small iris scalpel of his own design, which had a straight, dull back, a long, straight cutting edge and a rounded point. With this he made his puncture back of the limbus on the temporal side, passed it directly through the iris from behind into the anterior chamber, across to the nasal side, keeping the edge of the knife turned back against the iris throughout the whole maneuver. He was thus able by the most delicate pressure to make a horizontal incision. If the incision was too

[25]Adams. *Treatise on Artificial Pupil*, 1819, p. 34.

short he again carried the knife forward and again partially withdrew it, always cutting in the same plane.

Kuhnt's Operation for Secondary Cataract.

Kuhnt,[26] in order to make the opening more permanent, devised an operation in which a piece of the iridic membrane is removed. He uses a narrow-bladed, stiff linear cataract knife for his incision. This knife he plunges through the cornea and underlying membrane at a point about midway between the horizontal diameter and the inferior end of the vertical diameter of the cornea. As soon as the point perforates the after-cataract, he depresses the handle and passes the knife across the posterior chamber until the point has reached a corresponding position on the opposite inferior quadrant of the cornea. He then depresses the handle of the knife still more and makes a counter-puncture through the membrane and the cornea. He con-

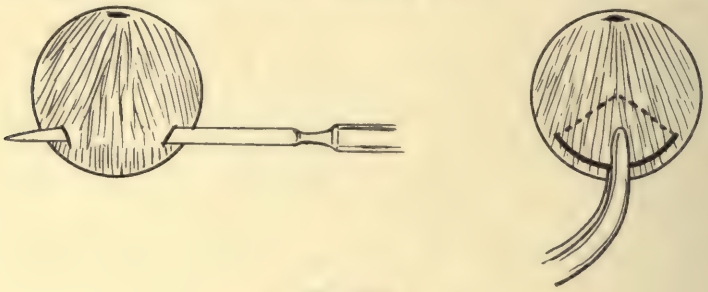


Fig. 683.
Kuhnt's Operation.

tinues his incision, emerging in the clear cornea just above the limbus. The upper lip of the wound in the after-cataract is then seized, drawn forward and a piece excised with scissors by means of two incisions meeting above, so that a triangular piece of the membrane is freed and removed from the eye. He advises protecting the wound by means of a large conjunctival flap which is brought forward and stitched in such a manner as to cover the lower half of the cornea.

Iridocystectomy in Closed Pupil.

Knapp[27] describes an operation of this character as follows: "Under cocaine anesthesia a Beers' cataract knife pierces the cornea about 3 or 4 mm. above the lower corneal margin, opposite the scar from the extraction, and transfixes the iris or pupillary pseudo-membrane by an opening 3 or 4 mm. long. The knife is withdrawn. With a blunt hook the lower lip of the iris wound is seized, drawn out of

[26]Kuhnt. Ueber Nachstaaroperationen. *Zeitsch. für Augenheilk.*, 1899, Vol. I, p. 151.
[27]Knapp. *A System of Diseases of the Eye*, Vol. III, p. 792.

the eye and abscised close to the cornea. There are scarcely any accidents. The healing is usually prompt and yields most surprisingly good visual results. Prolapse of the vitreous is not infrequent during this operation."

Iridotomy by Ziegler's Method.

Ziegler's operation[28] is a V-shaped iridotomy with his modification of Hays' knife-needle. His own description of the procedure is as follows: "*First Stage.* With the blade turned on the flat, the knife-needle is entered at the corneo-scleral junction, or through the upper part of the cornea, and passed completely across the anterior chamber to within 3 mm. of the apparent iris periphery. The knife is then turned edge downward, and carried 3 mm. to the left of the vertical plane. *Second Stage.* The point is now allowed to rest on the iris-membrane, and with a dart-like thrust the membrane is pierced. Then without

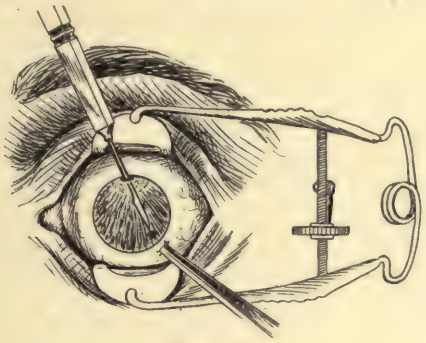


Fig. 684.

Ziegler's Iridotomy for After-cataract. The Knife-Needle is in the Anterior Chamber.

making pressure on the tissue to be cut, the knife is drawn gently up and down with a saw-like motion until the incision has been carried through the iris tissue from the point of the membrane puncture to just beneath the point of the corneal puncture. This movement is made wholly in a line with the axis of the knife, the shank passing to and fro through the corneal puncture, and the loss of any aqueous being carefully avoided. *Third Stage.* The pressure of the vitreous will now cause the edges of the incision to immediately bulge open into a long oval through which the knife blade is raised upward, until above the iris-membrane, and then swung across the anterior chamber to a corresponding point on the right of the vertical plane, which, owing to the disturbance in the relation of the parts made by the first cut, is now somewhat displaced and the second puncture

[28]Ziegler. *Trans. of the Ophthal. Section A. M. A.*, 1908, p. 375,

must be made at least 1 mm. farther over, i. e. 4 mm. to the right of the vertical plane. *Fourth Stage.* With the knife point again resting on the membrane, a second puncture is made by the same quick thrust, and the incision rapidly carried forward by the sawing movement to meet the extremity of the first incision, at the apex of the triangle, thus making a converging V-shaped cut. Care must be taken at this point that the pressure of the knife blade on the tissue shall be most gentle, and that the second incision shall terminate a trifle inside the extremity of the first, in order that the last fibre may be severed and thus allow the apex of the flap to fall down behind the lower part of the iris membrane. If the flap does not roll back of its own accord it may be pushed downward with the point of the knife. When the operation is completed, the knife is again turned on the flat and quickly withdrawn."

It sometimes happens, as in cases where there has been a long continued irido-cyclitis, that the retraction of the triangular piece of

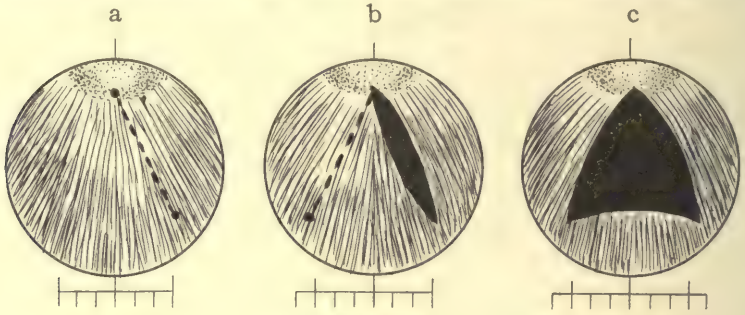


Fig. 685.
Ziegler's Operation.
a. Plan of First Incision.
b. First Incision Completed. Plan of Second Incision.
c. Pupil Resulting from V-Shaped Iridotomy.

the after-cataract included between the V-shaped incisions is insufficient to leave a central opening. Ziegler then advises that the V-shaped flap be pushed downward with the point of the knife and if this maneuver is not successful the knife is turned so that the blade is parallel to the surface of the iris and by a quick thrust is pushed through the base of the triangular flap and then by means of a sawing motion cut across its fibres in which case it will fall back upon the pedicle that remains. If by this procedure the desired result is not obtained, he withdraws the knife-needle and re-introduces it far enough away from the apex to secure proper leverage, and again makes an incision across the base of the triangular flap. The technique of this operation is difficult, but in the hands of skilled operators has been very satisfactory.

Ziegler sometimes modifies his operations by making two punctures and a cross incision in the after-cataract.

OPERATION FOR COMPLICATED AFTER-CATARACT BY THE USE OF SCISSORS,

The difficulty experienced by many operators in attempting to split the iris with a knife in complicated after-cataract has caused them to turn to some form of operation in which the incisions in the after-cataract are made with scissors. Owing to the fact that the opening of the blades in ordinary iridotomy demands too large an incision in the cornea a special form of scissors is needed. The essential requirements in scissors for this purpose are that the blades shall be thin and narrow, so that when closed they can pass through a comparatively small opening in the cornea, and that the blades shall be able to separate within the globe without materially widening the diameter of the instrument at the point where it passes through the

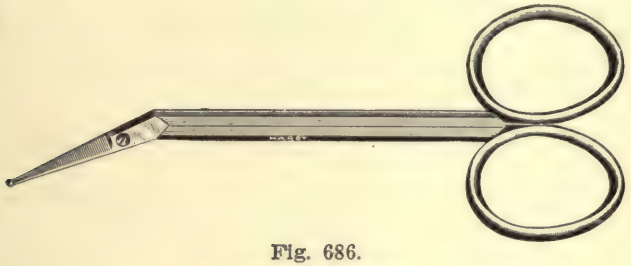


Fig. 686.
Maunoir's Scissors.

cornea. The first instrument of this sort was described by Maunoir of Genoa, in 1802. He used a pair of scissors with very thin, narrow blades which when closed were not thicker than a common probe. The blades were seven-tenths of an inch long and bent so as to form at the joint an angle of 140°. The extremity of the superior blade was blunt or round-pointed for use in the anterior chamber, and the inferior blade sharp at the point for the distance of one line on the back as well as on the cutting edge. The scissors were intended to be introduced flat, and then turned so that the sharp point should pass through the membrane.

deWecker's scissors have been much used. They differ from Maunoir's in that the handles resemble in shape those of an ordinary pair of iridectomy forceps which have been hinged at the side and end, to open laterally. When the handles are in this position the blades are open. At the point at which the blades cross they are bent anteriorly to an obtuse angle. The original instrument had both blades rounded on the ends, but in recent models one blade is pointed. A

spring holds the handles apart on the side opposite the hinge. These scissors are an admirable instrument, but are often clumsily made.

Ferguson's scissors resemble deWecker's in general shape but the blades are turned in the opposite direction and lie closed instead of open when the scissors are at rest. The blades are sharp on the outer as well as inner edges so that they cut when the blades are opening, and in the usual manner when the spring is allowed to close them. They are separated by the same action that closes deWecker's scissors to an amount that, before operating, can be regulated by a screw.

Noyes' iridotomy scissors are perhaps the easiest to use of any which have been devised. The handle is in every respect similar to that of an ordinary cataract knife and the scissors consist of a fixed blade (with a rounded point) that is inserted into the end of the handle.

This blade is crossed 12 mm. from its point by another which has a sharp point. The proximal end of the movable blade extends to the handle of the instrument and is broadened, thickened and corrugated in order that the finger shall not slip when it is pressed down to close

Fig. 687.
Noyes' Iridotomy Scissors.

the blade. The blades are very delicate and narrow, only 1 mm. broad, and are held apart by a spring.

Its advantages are that with the thumb placed on the end of the lever, the instrument is grasped precisely as the operator is accustomed to hold his Graefe cataract knife. The bulk of the blades is so small and their length so short that the incision can be made in the after-cataract with the pivot practically in the corneal wound. This enables them to be used easily through the smallest possible incision.

Operation with deWecker's Scissors.

deWecker[29] made his corneal incision 4 mm. in length and with a stop-keratome. He then partially withdrew the knife, allowed the aqueous to escape slowly and when the iris came forward thrust the knife forward again, and made an opening in the iris 2 mm. in length. Withdrawing the knife he introduced the scissors, with the sharp point through the opening in the membrane, and cut obliquely from either extremity of the incision toward the apex of a triangle. He then grasped the triangular flap with forceps and removed it.

[29]deWecker. De L'Iridotomie. *Annales d'Oculistique*, 1873, p. 123.

Instead of the above operation deWecker sometimes used the following procedure: He made the corneal incision and opening in the iris membrane as above described, then introducing his scissors as before he cut from the center of his opening in the iris at an oblique angle; then swinging the scissors about he made an incision in the opposite direction, thus forming an inverted V. If the flap thus formed did not retract sufficiently, he grasped it with forceps and tore it across

Operation with Ferguson's Scissors.

A small incision is made in the cornea with a lance-shaped knife through which Ferguson[30] introduces his scissors closed and pierces the capsule at the center of the desired opening. The blades are then separated and their sharp outer edges cut the capsule to the required extent without dragging on the ciliary processes or on any adhesions that may be present. If it is desirable to make other incisions to get a good opening, one blade can be placed behind the membrane and the other in front and the scissors used in the same manner as deWecker's instrument.

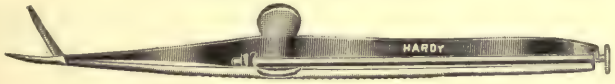


Fig. 688.
deWecker's Iridotomy Scissors.

Operation with Noyes' Scissors.

This operation has often been performed by the writer, and is done in the following manner: The corneal incision is made just anterior to the limbus, above, with a Graefe iridotomy knife. The blade of this knife is bent upon the shank at the end of its cutting edges. It has a sharp point and the cutting edges are long and parallel to each other. The width of the blade is 1 mm. The point of the knife is inserted parallel to the plane of the iris and after it has entered the anterior chamber to the width of the blade, the point is depressed and thrust through the after-cataract until the full width of the blade is engaged in the membrane. It is then withdrawn, the blade returned to the plane of entrance and gently withdrawn from the cornea. If this is done carefully the anterior chamber need not be evacuated. Noyes' scissors, with the blades closed and the thumb or forefinger upon the movable handle, is introduced through the wound, the pressure relaxed so that the spring separates the blades, the sharp point of the movable blade is carried through the opening in the capsule, the rounded point of the fixed blade passed anteriorly to the after-cataract downward and inward to the distance necessary, and the blades closed by pressure

[30]Ferguson. *Ophthalmic Review*, 1894, p. 59.

upon the movable blade. Pressure is again relaxed, which opens the blades of the scissors, and the instrument swung to a similar position downward and outward, and the incision repeated in this direction. If the triangular flap freed by this V-shaped incision does not retract sufficiently the scissors can be turned so that the blades are in the plane of the iris and an incision made entirely or partially across the flap which will produce a large, free opening. The instrument is then closed and withdrawn. The advantage of this operation with the Noyes instead of the deWecker scissors is that the blades are so narrow they

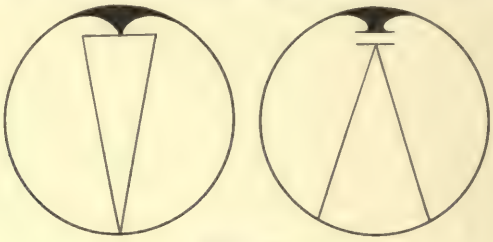


Fig. 689.

The Two Forms of Iridotomy by Means of deWecker's Iridotomy Scissors. (deWecker.)

can be opened to a width sufficient to make the required incision in the capsule through a corneal opening of 2 mm. or less, thus avoiding the danger of prolapse of vitreous into the wound and insuring prompt closure of the corneal incision.

When the secondary membrane is very thick and inelastic the writer has often successfully operated with Noyes' scissors as follows: The incision is made with a Graefe iridotomy knife (broad needle) as before described and is extended by use of the cutting edge of the instrument to 4 mm. The opening in the after-cataract is made approxi-

Fig. 690.

Graefe Iridotomy Knife or Bent Broad Needle.

mately of the same width. The Noyes' scissors are then introduced, as above described, at one end of the incision and a vertical cut in the membrane made of the desired length. The scissors are then withdrawn and reintroduced at the other end of the incision in the cornea and after-cataract and a parallel, vertical incision is made. The scissors are then turned and an oblique incision made across the tongue of capsule, the free portion of the membrane is removed either by gently grasping it between the blades of the scissors or by the introduction of a pair of iridectomy forceps. The triangular, free flap remaining eventually contracts. A good opening, which does not readily

close, is obtained by this procedure. The operation is best performed under general anesthesia.

Punches for Making Openings in After-Cataracts.

A number of instruments have been devised for the purpose of punching out a piece of the after-cataract and withdrawing it from the wound. The corneal incision is made with a broad keratome at the limbus and the point of the keratome is carried through the membrane in the same manner as has been described in operations with scissors. The punch is then introduced through the wound, the lower blade carried behind the after-cataract and the upper blade passed in front of it, as in an operation with scissors. The punch is then closed and withdrawn. The objection to most of these instruments is that they require a large opening in the cornea and, unless they are very sharp, are apt not to make a clean cut through the membrane, so that when they are withdrawn considerable traction has been made on the ciliary body by dragging on an uncut tag of the after-cataract.

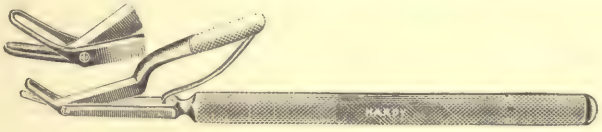


Fig. 691.
Stevenson's Capsule Punch.

Hemorrhage Following Operations for After-Cataract.

Bleeding from cut iris tissue is not infrequent. The absorption of the blood in the anterior chamber containing an after-cataract is much slower than in a normal eye. Hemorrhage is said to be much more profuse when the iris is cut transversely than when it is split in the direction of its radial fibers. This fact should be borne in mind when planning an operation involving the iridic tissues.

After-Care in Operations for Secondary Cataract.

Atropin should be instilled after the operation, and if there has been much hemorrhage a pressure bandage ought to be applied. The patient should be placed in bed and kept quiet for 24 hours, after which the bandage can be removed and the patient allowed to sit up in a shaded room. After the wound is closed if the effused blood does not absorb promptly, the process can be hastened by instillation twice a day of a 10 per cent. solution of dionin. The atropin should be continued for two weeks at least.

CHAPTER XII.

OPERATIONS ON THE RETINA.*

By CASEY A. WOOD, M. D., Chicago, Ill.

Surgical Anatomy—Historical Review, Early Recognition of Detached Retina and of Operations for its Relief—Surgical Pathology of and Anatomical Changes in Detached and Reattached Retina—Causes of Detachment of the Retina—Frequency of Retinal Separation—Relations of Reattachment of the Retina to Central and Peripheral Vision—Prognosis in Operative Treatment—What Constitutes a Cure of Retinal Detachment?—Relapses in the Course of Operative Treatment—Spontaneous Reattachment of Separated Retina—Supplementary (Non-Operative) Measures—Simple Scleral or Sclero-Choroidal Puncture—Posterior Sclerotomy—Paracentesis of the Sclera—Posterior Ophthalmotomy—Iridectomy in Detachment of the Retina—Puncture or Incision of the Detached Retina Itself—Dislaceration with Two Needles—Aspiration of the Subretinal Fluid—Permanent Drainage of the Subretinal Sac—Drainage with a Gold Thread—Attachment of the Displaced Retina to a Scleral Wound—Puncture of the Eyeball with the Galvanocautery—Subconjunctival Injections—Galvanocautery of the Sclera—Suturing the Separated Retina to the Choroid and Sclera—Electrolysis of the Postretinal Fluid—Induction of Labor in the Treatment of Ablatio Retinae Due to the Albuminuria of Pregnancy—Mueller's Operation—Deutschmann's Operations—Bisection, with and without the Intravitreous Injection of Sterile Animal Vitreous—Lang's Operation—Vertical Incision through the Sclera—Wolfe's Operation—Discission of Vitreous Membranes in Connection with Retinal Detachment—Punctiform Cauterization—Extensive Longitudinal Incisions of the Sclera—Iodine Injections into the Subretinal Sac Only—Summary—Embolism of the Central Artery of the Retina—Surgical treatment.

Surgical Anatomy.

For surgical purposes the retina may be regarded as the expansion of the optic nerve within the eye and is the first membrane lining the posterior chamber one meets from before backwards. It varies in thickness from 0.1 mm. at the *ora serrata,* where is is thinnest, to 0.5 mm. at the macula. The principal surgical points or areas are the *optic disc* (*porus opticus,* disc, *papilla,* optic nerve entrance) and the *macula lutea,* or yellow spot. The latter area is elliptical in shape and

*A part of this chapter was read before, and will be found in the pre-sessional reprints of, the Oph. Sec., A. M. A., June 1910.

from one to two mm. in diameter. In its center is a third important area, a depression called the *fovea centralis*, 0.2 to 0.4 mm. in diameter. Within the optic papilla is a physiological excavation from which the retinal vessels generally arise.

The retina lies upon the choroid externally while internally it is

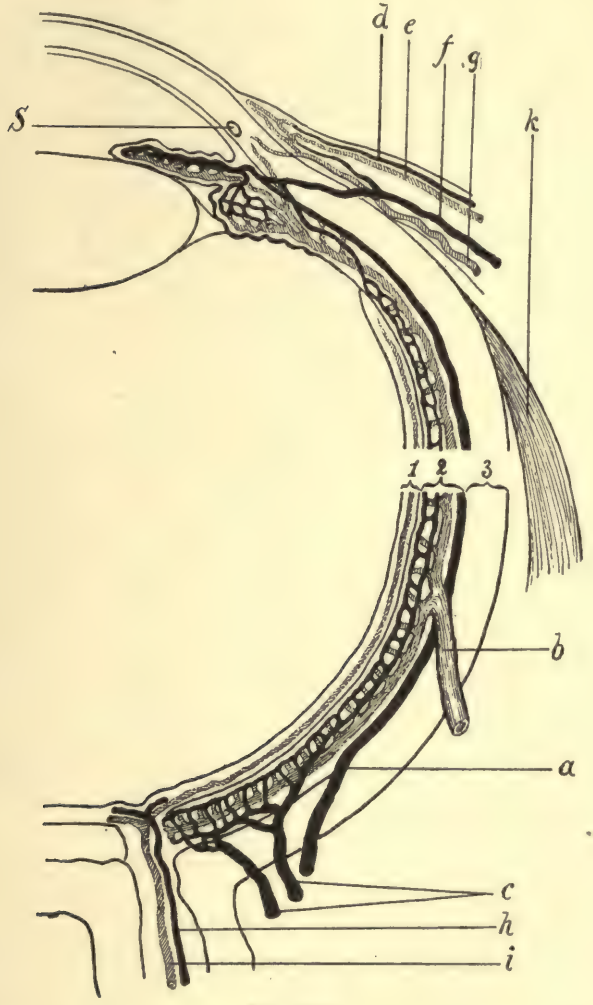


Fig. 692.

Diagramatic Section of the Eyeball showing the Surgical Relations of the Retina.

a. Long posterior ciliary artery. b. Vena vorticosa. c. Short posterior ciliary arteries. d. Conjunctival artery. e. Conjunctival vein. f. Anterior ciliary artery. g. Anterior ciliary vein. h. Central artery of the retina. i. Central vein of the retina. k. Rectus muscle. s. Canal of Schlemm. 1. Retina. 2. Choroid. 3. Sclera.

in close apposition to the hyaloid membrane surrounding the vitreous body. It covers nearly the whole of the ocular interior, extending from the *optic papilla* to the pupillary margin of the iris. It is generally divided into three zones. The *optic zone* of the retina extends from the disc to the *ora serrata;* the *ciliary zone* from the *ora serrata* to the ciliary margin of the iris; the *iridic zone* covers the posterior surface of the iris.

Of the foregoing zones the first is the only one sensitive to light; the ciliary and iridic portions contain pigment layers only; no nerve elements. The ciliary portion consists practically of a single layer of elongated cylindrical cells, their surfaces having a cuticula; externally they are connected wtih the pigment layer.

The iridic part is made up chiefly of two layers; an anterior layer with spindle cells and a posterior layer mostly composed of pigment cells.

In detachment of the retina that membrane is found to be the most firmly attached and to resist separation best at the optic papilla, where it is continuous with the optic nerve tissues; it adheres to a much less extent at the macular region. For anatomical reasons separation of the retina rarely occurs past the ora serrata.

The *central artery of the retina* furnishes an example of an end-circulation. There are no anastomoses with other circulatory systems. In consequence of this an embolus entering the main trunk floats in the blood current until it reaches a vessel so small that it cannot further pass, plugs this and so cuts off all that part of the retina to which the branch furnishes a nutritive supply.

The central artery, as it passes forward from the substance of the optic nerve, is somewhat contracted in making the turn to ascend to the optic entrance. In consequence of this tissue arrangement, an embolus is liable to lodge immediately behind the *lamina cribrosa,* especially if it be of large size.

Incisions and Punctures of the Retina.

The proper point of entrance of any cutting instrument intended to reach the retina is best determined by the ophthalmoscope and should, when possible, be so made that the ciliary body and larger bulbar vessels are avoided while directing the knife into the posterior chamber. These small areas are depicted in Fig. 693, and although an aseptic, straight needle, lance or narrow knife can, as a rule, be plunged into almost any sterilized eye at or near the equator without serious risk, yet it is safer to choose, when possible, one of the four regions indicated.

If this rule be followed there is rarely any extensive bleeding and infection to mar the results of the operation.

With more extensive interference with the globar walls and tissues of the ocular interior the danger of these and other complications is, of course, greater, the gravity of the operation depending upon the state of the eye as well as the locality and extent of the wound.

It is not always possible to choose the safest point or area for scleral punctures or incisions. In the same way one may not have a choice either of the incisional length or direction—whether longitudinal, meridional or oblique, whether 2 mm. or 20 mm. long. Where, however, a selection can be made less damage is done to the ocular walls and there is *less danger of serious intraocular hemorrhage if the selected area be between the margins of neighboring straight muscles* (See Fig. 693) *and if the incision or puncture be longitudinal, not too close to the equator, and directed towards the geometrical center of*

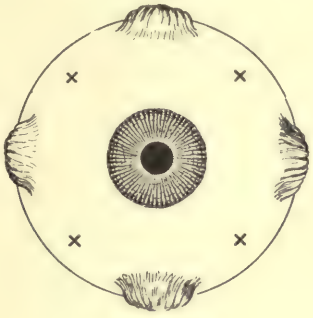


Fig. 693.

Points of Election 8-12 mm. from the Sclero-corneal Junction, between the Tendinous Insertions of the Straight Muscles, for Bulbar Punctures and Incisions.

the eyeball. If these precautions can be taken one may steer clear of the lens, the vortex veins and the posterior ciliary vessels.

The Early Recognition of Detached Retina and the First Operations for Its Relief.

Whether or not Saint-Yves (1722), Morgagni (1740), Wardrop (1818), and Panizza (1828) fully appreciated the condition later described as *amotio sive sublatio retinæ,* there can be no doubt that some of the findings referred to by them as *hydrops subchorioidealis* and *hydrops chorioideæ internus* were genuine examples of detachment of the retina.

James Wardrop[1] certainly gives a definite clinical and anatomical pic-

[1]Wardrop. *The Morbid Anatomy of the Human Eye.* Vol. II., p. 71 and 291, Second Edition, 1834.

ture of the disease. "I have," says he, "had an opportunity of dissecting several eyes where a serous fluid had collected between the Choroid Coat and Retina. In these cases, the retina and vitreous humor were displaced and compressed by the morbid collection of water; the vitreous humor being more or less absorbed, while the retina was shriveled up, and formed a white bundle, extending through the center of the eyeball, from the entrance of the optic nerve to the posterior part of the crystalline capsule. The choroid coat was unchanged."

His Plate xvii. plainly shows the retinal detachment exactly as described.

That William Mackenzie[2] was well acquainted both with the pupillary and anatomical appearance of detachment of the retina and the need for surgical interference in its treatment, is quite evident from a perusal of both his earliest and his later text-books.

He says, *inter alia*, "It has been ascertained by dissection that a watery fluid is sometimes present in sclerotic staphyloma between the sclerotica and the choroid, whereby the latter tunic is pressed inwards and the former outwards. There are also good grounds for believing that *a similar effusion forms occasionally between the choroid and the retina.* If the fluid collected in the latter situation is not evacuated by puncturing the staphyloma, it may accumulate to such a degree as to press the retina before it, and having at last produced, by means of its continued pressure, an absorption of the vitreous humor, *it will gather the retina into a cord*, as sometimes happens in arthritic and in mismanaged cases of syphilitic ophthalmia. *A third situation of the hydrophthalmic effusion is between the retina and the hyaloid.* Perhaps within the hyaloid is as frequent a seat of the watery effusion as any other; and in this case the structure of the vitreous body is broken up and dissolved."

"Puncturing the sclerotica and choroid, so as to evacuate the fluid collected within the eye, is a remedy of much importance in the treatment of this disease. The operation is performed with the extraction-knife or with a broad cataract needle, thrust, not in the direction of the lens, which it might readily wound, and render opaque, but towards the center of the vitreous humor. The instrument need not penetrate deeper than the eighth of an inch. A little blood is usually discharged, along with aqueous fluid of a slightly glutinous consistence. It may be repeated every eight days, or at longer intervals, according to the state of the eye."

Under the caption, "Sub-choroid Dropsy," Mackenzie gives in full (p. 663, American Edition) the history of a case operated on by James Ware, to which further reference will be made when speaking of scleral puncture.

Mackenzie says that in "suspected cases of sub-choroid hydrophthalmia, there can be no doubt of the propriety of following the practice of Mr. Ware, and puncturing the eye at the usual place of passing the cataract needle through the sclerotica and choroid. Mr. Ware recommended a grooved needle for this purpose, so that the fluid might more certainly escape; but a better plan is, to puncture with a broad cataract needle, or the point of the extraction knife, and then hold the edges of the wound apart by means of a small probe. Care should be taken in making the puncture to direct the point of the instrument, so that it may not wound the posterior part of the crystalline capsule. The operation may be repeated from time to time, should the symptoms seem to demand it."

Following the invention of the ophthalmoscope in 1851 the fundus ap-

---

[2]Mackenzie. *A practical treatise on the Diseases of the Eye.* London, 1830, p. 460. See also the American Edition of 1855; p. p. 506, 507 and 510.

pearances of retinal separation were accurately pictured by Coccius[3], while von Graefe[4] shortly afterwards (1854) gave us as complete a description of the disease in all its aspects as one finds in any modern text-book.

These definite clinical, pathological and ophthalmoscopical researches were followed in the fulness of time by attempts to replace the separated membrane through the employment of remedies mostly operative. It is with these efforts, extending over half a century, that I shall shortly deal.

Surgical Pathology of and Anatomical Changes in Detached and Reattached Retina.

Leber, Nordenson and other observers have noticed a rent or rents in the separated membrane.

Nordenson[5] saw these lacerations in more than one-third of the 119 cases he examined, and *located the primary lesion in the choroid and ciliary body.* A uveitis sets in that is followed by fibrillary metamorphosis and consequent shrinking of the vitreous body. The vitreous becomes firmly attached to the retina and in contracting not only detaches the latter from its choroidal bed, but tears it, producing the rents just referred to. Through these openings, often quite minute, the post-hyaloid effusion passes. If the detachment occurs, as it generally does, in the upper part of the globe, the fluid gravitates downward and further tends to increase the detachment.

The effect of detachment upon the retinal elements is, of course, disastrous. The light and form perceiving elements suffer to some extent at once and this defect is further increased by prolonged deprivation of the nutriment which the retina derives from the underlying ciliary and choroidal vessels.

Leber divided detached retina into three categories, depending mostly upon the histological conditions.

A. Shrinking of the vitreous body; outpouring of a preretinal fluid which, *through a tear or tears in the retina,* passes behind the latter and gradually forms a serous sac. This might be styled the *acute form* of separation of the retina.

B. In *chronic cases* of retinal detachment shrinking of the vitreous body takes place *without tears in the retina* and without fluid passing from the posterior chamber behind the retina.

C. That form of detachment that occurs with cyclitis when there is a fibrinous exudate that eventually ends in vitreous shrinking

This is not the place to enlarge upon the dozen or more additional theories that have been put forward by various observers during the last 50 years to account for various forms of this disease. It might, however be mentioned that disease of the choroid itself offers an explanation of some cases of *amotio retinæ.*

deSchweinitz and Shumway[6] have particularly drawn attention to the presence of cystic degeneration of the choroid in retinal detachment and

---

[3]Coccius. *Ueber die Anwendung des Augenspiegels,* 1853.

[4]Von Graefe. Notiz über die Ablösungen der Netzhaut von der Chorioidea. *Archiv. f. Ophthal.,* Vol. I, 1854, p. 362, and in several subsequent volumes.

[5]Nordenson. *Die Netzhautablösung,* Wiesbaden, 1887.

[6]deSchweinitz. Histological Description of an Eyeball with Dropsical Degeneration of the rod and cone Visual Cells of the Retina which Clinically Simulated Glioma. *Trans. Am. Oph. Soc.,* 1901, p. 283.

there seems no good reason why a metamorphosis that weakens the union between the retina and choroid might not at least predispose to a detachment of the former.

Uhthoff[7] describes the retinal and choroidal changes in a case of spontaneous reattachment of the separated retina of a bilateral retinitis albuminurica.

Raehlmann believes that various influences may produce alterations in the choroid followed by a serous or even solid exudation which, accumulating, pushes the retina before it, forming the so-called post-retinal sac. The contents of the sac may or may not, in time, communicate with the hyaloid chamber by way of openings in the retina.

Causes of Detachment of the Retina.

No rational treatment—medical or surgical—can be undertaken without a fairly definite idea of the *causation* of this disease. Without going too deeply into the subject it may be said that the affection is most common in *men between the ages of* 44 *and* 60. The *chief exciting causes* are those agencies that increase intraocular strain, such as lifting heavy weights, stooping, vomiting, constipation, childbirth, sneezing, severe injuries to the globe or its neighborhood, etc.

A table, representing an investigation of 300 cases of separation of the retina examined in Horner's klinik,[8] furnishes a satisfactory *clinical* index of its pathogenesis, especially of the *predisposing causes*:—

Myopia	144	cases	48 per cent.
Injury	49	"	16.3 per cent.
Iritis, uveitis	11	"	3.6 per cent.
Choroiditis	10	"	3.3 per cent.
Hemorrhagic diathesis	23	"	7.6 per cent.
Congenital anomalies	2	"	0.6 per cent.
Congestive causes	11	"	3.6 per cent.
Opacities of the vitreous alone	22	"	7.2 per cent.
Idiopathic detachments	28	"	9.3 per cent.
	300	"	100 per cent.

Tumors of the retina and choroid, as well as solid or semi-solid post-retinal exudates, are, of course, not included in this table, while a few instances of *albuminuric retinitis* are included under "hemorrhagic diathesis."

Frequency of Retinal Separation.

Sattler[9] asserts that detachment of the retina occurs five or six times in every 1,000 cases of ocular disease and that about 8 per cent. of these are bilateral.

These figures, it must be remembered, refer to Germany where patients with high degrees of myopia (the commonest predisposing cause of the affection) are more frequently seen than in this country.

---

[7]Uhthoff. Zur Wiederanlegung der Netzhautablösung. *Bericht der Ophthalmologischen Gesellschaft*, 1903, p. 4, with a demonstration of the preparation on page 270, of the same volume.

[8]Ernest Walter. *Klinische Studien über Netzhautablösung*, Inaug., Diss., 1884.

[9]Sattler. Ueber die Behandlung der Netzhautablösung, p. 15, and Behandlung der Netzhautablösung, p. 56, *Deutsch. Med. Wochenschr.*, 1905, 1 and 2.

Its frequency in France may be estimated from a report[10] (May, 1887), of a committee of the *Société Française d'Ophtalmologie* involving 67,464 eye patients; 416 exhibited separation of the retina.

Relations of Reattachment of the Retina to Central and Peripheral Vision.

The diminished visual acuity and the lateral defects in the field of vision noticeable to the patient are, as a rule, much improved when the separated membrane is restored to its normal position. Still, this result cannot always be counted on and its possibility or probability should be considered both by the patient and the surgeon before resort to operative procedures.

It is not rational to suppose, when the percipient elements of the retina are from any cause seriously damaged, the optic nerve the seat of disease, or the ocular media cloudy, that a reattachment, however perfect, can *per se*, be of much value to the patient. Such a situation followed by a reattachment Hirschberg[11] calls "*anatomische Heilung*," because the result is purely mechanical and has nothing to do with the visual function. The postoperative condition in such cases is paralleled when a mature cataract is extracted in a case of advanced *retinitis pigmentosa;* the operation may succeed but the hemerolope is not much better off, *quoad visum*, than he was before the operation. The possible improvement in eye-sight may, fortunately, be closely estimated from the history of the case, by testing the projection, by the use of the perimeter and by ophthalmoscopy. In any event it is wise to take a conservative view of the whole situation; it is better to promise too little than too much.

Prognosis in Operative Treatment.

Even under favorable conditions permanent cures of this formidable disease call for the exercise of much patience and endurance both by the surgeon and the sufferer. Even then the outcome is at least doubtful. One can, however, usually give a fairly definite reply to anxious enquirers after fully considering the causes, character, extent, duration and the coincident ocular changes of a particular example of retinal separation.

In a general way it may be said that, as Sattler[12] tersely puts it, *the smaller the detachment and the more recent the case the more encouraging the prospect.*

Schöler[13] found in his experience cases most successfully treated are *recent and present a clear vitreous and a bagging of the detached retina*, thus indicating the presence of a small quantity of sub-retinal fluid. He regarded as unfavorable, concomitant disease of the media, especially a fluid and turbid vitreous, high myopia, extensive detachment of the retina and marked disease of the choroid.

---

[10]Rapport sur l'enquête de la Société relativement aux décollements de la rétine. *Bulletins de la Soc. Française d'Ophtal.*, 1887, p. 67.

[11]Hirschberg. Selbst-Heilung kurzsichtiger Netzhautablösung, *Centralbl. f. pkt. Augenheilk.*, 1891, p. 168.

[12]Sattler. Ueber die Behandlung der Netzhautablösung, p. 15, and Behandlung der Netzhautablösung, p. 56, *Deutsch. Med. Wochenschr.*, 1905, 1 and 2.

[13]Schöler. *Zur Operative Behandlung der Netzhautablösung*, Berlin, 1889.

In considering the propriety of submitting the patient to surgical measures it must not be forgotten that the Committee of the Société Française[14] ended their report on all operations known to them at that time with these words: "Since we cannot affirm the certainty of *any* operative measure it may be stated that, *as a rule,* it is good policy to abstain from *any* surgical interference in the treatment of detached retina." However, we are, at the present time, able to take a more encouraging view of the situation.

What Constitutes a Cure of Retinal Detachment?

In my limited experience of this affection the *patient* is generally satisfied with useful central vision and the permanent disappearance of the lateral cloud in his visual field, even if the reattachment is incomplete. On the other hand, even if there is a satisfacory "anatomical cure," from the *surgeon's standpoint* the sufferer is, of course, not interested in that fact when his eyesight is not distinctly improved as a result of the treatment.

That a patient with detached retina may be spoken of as *cured,* the reattachment should be complete, or so nearly complete that he does not complain of symptoms, and the retina have retained its normal position for at least a year.

Relapses in the Course of Operative Treatment.

The hopes of both patient and surgeon are often doomed to disappointment because of secondary detachment of the replaced retina. It quite frequently happens that, after a complete reposition of the separated membrane (with demonstrable increase in both central and peripheral vision lasting for a considerable time), the retina is once more torn away from the choroid. This accident, due to various causes, has, in many instances, taken place while the patient was quietly lying in bed, under atropia and wearing a bandage.

Within the past few months I have witnessed in my own practice this mournful accident. The patient, a man, aged 55, had recovered almost his whole field for white and had improved in central vision from 10-200 and no Jaeger to 20-50 and ability to read coarse print, as the result of three "simple bisections" followed by rest in bed, atropine cycloplegia and pilocarpine sweats. He then "caught cold" and had a sharp attack of acute bronchitis, with severe fits of coughing. In a week, despite all treatment, the detachment, involving the macular region and about one-fourth of the retina in the temporo-inferior quadrants, was as pronounced as before and vision rapidly sank to its former level.

A ray of comfort and hope is thrown upon this discouraging fact in the surgical conduct of separated retina in that quite a number of brilliant and permanent cures have followed *persistent treat-*

[14]Rapport sur l'enquête de la Société relativement aux décollements de la rétine. *Bulletins de la Soc. Française d'ophtal.*, 1887, p. 67.

ment and the repetition of operations, in spite of these relapses. In my opinion, it is desirable in the preliminary discussion with the patient of the *"pros and cons"* of proposed operative measures that this irregular course of the disease be frankly stated. No surgical intervention should be undertaken unless all parties to it are willing to have the patient submit to repeated operations as long as there is a chance of recovery. Deutschmann, for example, has finally succeeded in several cases of relapse, after operating a dozen times or more.

Spontaneous Reattachment of Separated Retina.

Instances of this happy event, which Hirschberg calls *"physiologische Heilung,"* have been reported by many observers, although authors greatly vary in estimating their frequency.

Deutschmann, in 300 cases, has seen three spontaneous recoveries, or 1 per cent., Hirschberg four examples in 338, while Uhthoff reports a much higher proportion—28 cases out of 337—about 8.30 per cent.

Milliken[15] reports a case of detachment of the retina, confined to the macular region, occurring in a fairly healthy man, that resulted in practical recovery without treatment.

H. M. Post[16] gives a history of two cases, in one of which the retina resumed its proper position while the patient was in bed waiting for the removal of a cataract in the other eye. In another patient the reattachment occurred without any known cause and without treatment.

This subject is exhaustively discussed by Müglich[17] and later by Spämer[18] in the light of case-histories from Uhthoff's clinics in Marburg and Breslau. In a number of these cases there remained slight defects in the visual field or small areas of unattached or imperfectly attached retina, not noticed by the patient.

In some instances, however, the period of observation (less than a year) was not protracted enough to assure oneself that a return of the separation might not take place. In my judgment, one may place in the category of "physiological" cures quite a number of replacements thought to be due to rest in bed, sweats, dionin, mercurials, iodides, and other kinds of medical treatment, not to mention those following minor surgical interferences—subconjunctival injections, cauterization of the sclera, and the like. In any event, Müglich gives the histories of 136 published cases (1891) of detached retina in which there was complete replacement of the membrane without resort to any surgical treatment whatever, and these figures by no means exhaust the list to the year 1910.

Supplementary (Non-Operative) Measures.

In all, or nearly all, the forms of surgical intervention about to

[15]Milliken. Case of Muscular [Macular?] Detachment of the Retina with Reattachment and Recovery. *Western Reserve Med. Jour.*, Sept. 1895, p. 376.

[16]Post. Detachment of the Retina. *Amer. Jour. of Ophth.*, May, 1907, p. 129.

[17]Müglich. *Inaugural Dissertation*, Marburg, 1891.

[18]Spamer. *Inaugural Dissertation*, Breslau, 1904.

be described various kinds of *medical* treatment are also prescribed. While these operative aids are mentioned here because of this fact it is only fair to add that *numerous cures have been claimed for one and all of these non-operative measures alone,* as well as for almost any two or three of them combined.

Perhaps the most important remedy is the *prone position in bed* for weeks at a time, varied by daily removals to a couch or lounge. The patient should during the period of rest studiously refrain from any considerable exertion and must avoid straining at stool, sneezing, hawking, laughing and above all, *coughing.* During this state of complete relaxation he may, at the discretion of the surgeon, take such supplementary treatment as the case seems to demand.

Many observers combine with this form of "rest cure" the use of the artificial (Heurteloup) leech, atropia, simple protective or compression bandages, tinted glasses, a darkened room, laxatives, sudorifics, a restricted diet and the employment of certain drugs said to have a specific effect upon the vitreous changes, choroidal disease, subretinal effusion and the other accompaniments of the disease.

Freytag[19], after considerable experience with the pressure bandage, believes that it is without value in the conduct of cases of detachment of the retina.

On the whole, he thinks that the effect is rather harmful than otherwise. He also takes the view, held by a number of observers, that it is more likely that the majority, if not all, of the cures of separation considered to be due to the use of the bandage and similar minor procedures really belong to that rather large class of *spontaneous* cures. In corroboration of this contention he quotes the statistics of Uhthoff, who observed in 422 cases 36 permanent cures; of these 18 got well without treatment.

The most important of the *internal remedies* are *large doses of potassium iodide,* or *sodic salicylate* (Gifford) combined with *sweat baths,* with or without *pilocarpine.*

For example, an interesting account of the treatment of detached retina by means of pilocarpine and sodium salicylate combined is given by Emerson, who has reported encouraging results from the use of these remedies.

This aspect of the subject is considered at some length in Wood's *System of Ophthalmic Therapeutics,* to which the reader is referred for an account of those medical, dietetic, hygiene, and other (non-operative) measures, the employment of which is by many authorities thought to be as necessary to the relief and cure of this formidable disease as are the purely operative procedures.

Simple Scleral or Sclero-Choroidal Puncture.

Posterior Sclerotomy. Paracentesis of the Sclera. Posterior Ophthalmotomy.

This operation is intended to give vent to the subretinal fluid

[19]Freytag. Der Druckverbund in der Therapie der Netzhautablösung. *Munch. Med. Wochenschr.* No. 35, 1907, p. 1734.

which, from the earliest years of the ophthalmoscopic era, was known to be an almost constant accompaniment of *ablatio retinæ*. It was the first rational operation performed for the relief of the disease and was recommended and practiced by James Ware in 1805 and by Sichel, Sr.,[21] in 1859. I notice that Uhthoff gives priority in the performance of this operation to Kittel.[22] The probability is that the two last-

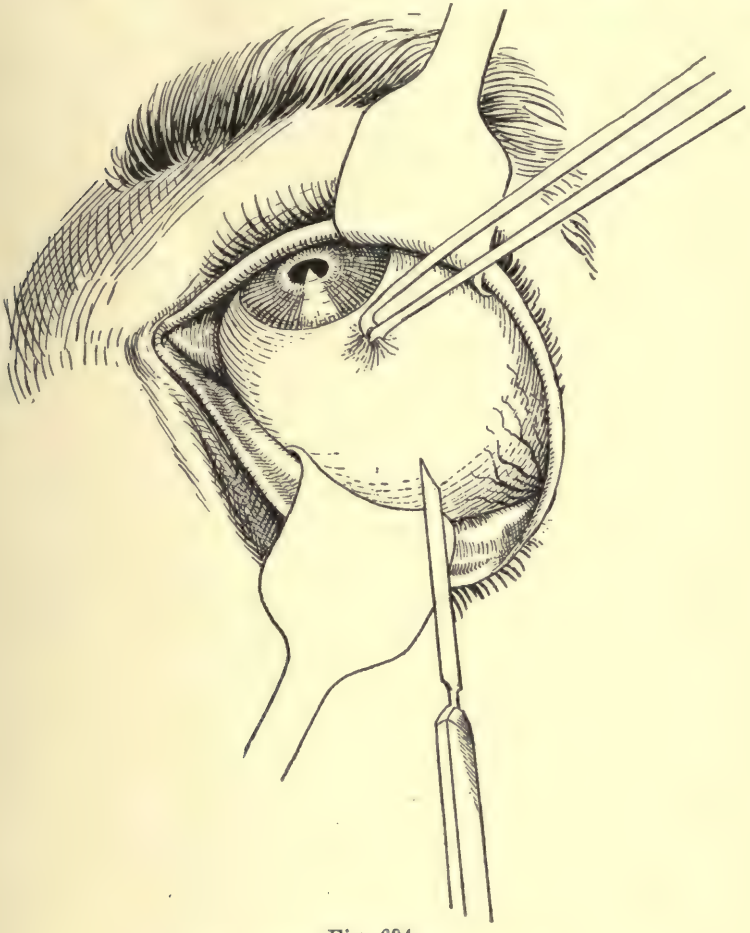


Fig. 694.
The Incision in Scleral Puncture.

named surgeons employed it about the same time. Von Graefe and von Kries[23] considered it of value while Schweigger held that in re-

[21]Sichel. *Clinique européene*, No. 29, 1859.
[22]Kittel. Punction der Netzhaut. *Wien, Allg. Med. Zeitschr.*, 22-23, 1860.
[23]Kries. Ueber die Behandlung der Netzhautablösung, *Archiv. f. Ophthalm.*, 23, I, 1877. p. 239.

cent cases and when followed by sweat baths, sodium salicylate and a pressure bandage, simple scleral puncture is among the most effective operations for detached retina.

In awarding to James Ware[25] the honor of having done not only the first operation for the relief of detachment of the retina, but also priority for the practice of posterior sclerotomy, I would like to quote his own words: "On making a puncture through the choroides, about the middle of the space between the rim of the cornea and the entrance of the optic nerve, a yellow colored fluid, as thin as water, immediately escaped through the wound; and on enlarging the incision, the retina was found to be collapsed, and to resemble a cone of a white color, the apex of which was at the entrance of the optic nerve, and its basis round the circumference of the crystalline humor. This humor, which could not now be accurately distinguished from the parts contiguous to it, seemed to adhere to its capsule, and the capsule to the posterior surface of the iris; and there did not appear to remain the smallest vestige of the vitreous humor."

"The operation was attended neither with difficulty nor danger. It consisted simply in the introduction of a common spear-pointed couching needle through the tunica sclerotica, a little further back than the part where it is usually introduced for the purpose of depressing a cataract. As soon as the instrument entered the eye a yellow-colored fluid immediately escaped, sufficient in quantity to wet a common handkerchief quite through. The needle was continued in the eye about a minute, in order to give the fluid a more ready way to come out; and as soon as it was withdrawn the discharge ceased. The tension of the eye was considerably diminished by the operation. A compress dipped in a saturnine lotion was bound upon it, and the patient put to bed."

Although the steps of this operation will be more fully described in the chapter on the Operative Treatment of Glaucoma, I may say here that the point of a broad needle or narrow cataract knife is, by the aid of the mirror, passed through the bulbar walls just far enough to tap the post-retinal sac. The retina itself is not wounded. The instrument is then withdrawn and in this act turned slightly, to allow a portion of the fluid to drain away. This manœuvre may be repeated almost indefinitely at proper intervals, say, of three days or a week. Atropine should be used and the patient is kept quiet in bed.

Scleral puncture seems to hold its own to the present time and, alone, or in conjunction with other forms of treatment, is practised more frequently in detached retina than most of the surgical procedures about to be mentioned. Cures following its performance are not uncommon, and, when practised within proper scleral areas, it is practically devoid of danger.

Greenwood,[26] for example, gives an account of a case treated by this means with improvement that was not, however, permanent.

deSchweinitz has had good results with scleral puncture when it is followed by large subconjunctival injections of physiological salt solution (q. v.) and has not found it necessary to increase the strength of the chloride sodium solution beyond 5 per cent. Subsequent to this treatment the patient should remain in bed.

---

[25]Ware. *Chirurgical Observations Relative to the Eye*, Vol. II, 1805, p. 238 and 514.

[26]Greenwood. Case of Retinal Separation, *Ophthalmology*, Jan., 1905.

An instance of cure is reported by W. H. McMullen.[27] The detachment had persisted for eleven months and after repeated punctures of the sclera, combined with rest in bed and a bandage, the patient entirely recovered.

M. Sachs has made a slight modification in the foregoing in that he makes a small incision behind and parallel to the equator and through it passes a *sickle-shaped knife* into the eye. In withdrawing the blade it makes a decided incision of the intraocular membranes and so increases the area of cicatricial exudation and subsequent adhesion of the wounded tissues.

Scleral Puncture with Incision of the Detached Retina.

As early as 1863 von Graefe[28] advised and practised discission of the detached retina, an operation which he performed over fifty times. Only in one instance was this procedure followed by the loss of the eye. In about one-half the cases improvement was observed at once, although better vision was claimed for a year and longer in only four instances.

The operation is a simple one and consists in the passage of a narrow knife, or knife-needle, through the globar walls, behind *the ora serrata* and, then, through the detached retina.

deWecker, Arlt, Bowman and others gave this procedure a fair trial with occasional good results, but it proved, on the whole, to be so unsatisfactory that it was finally abandoned. In more recent times it has received some support and has had a few advocates. See "Lang's Operation."

Dislaceration With Two Needles.

About the year 1863 Bowman[29] began to practise upon the detached membrane pretty much the same measures that he employed for discission of secondary cataract—the *double-needle operation.* He had in mind not merely making a rent in the retina for the purpose of allowing a flow of the subretinal fluid into the vitreous cavity, but the production of an adhesive inflammation between the floating membrane and its choroidal bed.

Aspiration of the Subretinal Fluid.

Long before Erik Nordenson published his classic work on the pathological histology of detached retina the attention of most ophthalmic surgeons had been directed to the sac of post-retinal fluid poured out, it was supposed, by the vessels of the choroid or retina, pushing the latter membrane forward and away from its pigment bed. This incident was regarded as the most important surgical fact connected with the disease and it was not strange, therefore, that the surgeon set himself the task of getting rid of it.

---

[27]McMullen. A Case of Detachment of the Retina in which Recovery followed Scleral Puncture. *Trans. Ophthal. Soc. U. K.*, Vol. 27, 1907, p. 124.

[28]V. Graefe. Perforation von abgelösten Netzhauten und Glaskörpermembrane. *Archiv f. Ophthalmologie*, IX, 2, 1863, p. 85.

See also Zehender's report in the *Klin. Monatsbl. f. Augenheilk.*, 1866, p. 241.

[29]Bowman. On Needle Operations in Cases of Detached Retina. *Ophthalmic Hospital Reports*, No. 19, 1864, p. 133.

For this purpose de Wecker invented a *trocar*, to be used in tapping the subretinal sac much as one would a dropsical kneejoint; Secondi described his operation of *hydrodictyotomy* and Galezowski aspirated, or suggested the *aspiration of the postretinal fluid with a modified Dieulafois' syringe.* Weber advised the use of a more complicated apparatus to accomplish the same end—*a double canula and syringe* for the dual purpose of aspirating the watery secretion and of injecting an "indifferent fluid" into the vitreous cavity —not only to fill the vacuum but to press back the detached membrane into its proper place. More recently Mooren[30] has claimed good results from simple aspiration of the fluid with an ordinary (Pravaz) hypodermic syringe.

These operative measures, however ingenious, failed, for evident reasons, to produce the expected result and were soon abandoned and forgotten.

Permanent Drainage of the Subretinal Sac.

The temporary reduction of the supply of subretinal fluid was quite early seen to be of little use in bringing about a lasting reposition of the separated retina. This observation is responsible for an attempt by de Wecker[31] (and Grizou) to establish *permanent drainage* of the subretinal exudation, in the hope that it would be followed by a final return of the retina to its resting place against the choroid. He consequently passed a curved needle, armed with a very fine gold thread, through the scleral wall and the choroid and, making a counter-puncture about a centimeter from the point of entrance, brought it out and tied the two ends over the conjunctiva. As might have been expected this procedure was not only unsuccessful, but the metal wire irritated all the ocular structures into which it came in contact and endangered the integrity of whole eyeball. It has consequently long passed into the limbo of forgotten surgical enterprises.

Mm. Ribard[32] gave the results of treating eight cases by this *anse à filtration.* They are not worth serious consideration, although a note is made that there was *"tolèrance parfaite"* in most of the cases, and the author evidently believed in their efficacy.

Attachment of the Displaced Retina to a Scleral Wound.

As early as 1871 Meyer, having failed by other operative interferences to replace the retina in a case of detachment, conceived the plan of passing a suture through the membrane and drawing it to an opening in the scleral wall. *"Je eu recours,"* said he, *"à un procédé opératoire tout nouveau et qui consiste à enclaver la portion decollée de la rétine dans une plaie sclératicale"* but it does not appear to have appealed to the imagination of other ophthalmic surgeons.

Iridectomy in Detachment of the Retina.

Inasmuch as this popular operation has been called into play in

[30]Mooren. *Fünf Lustren Ophthalmolog. Wirksamkeit,* Wiesbaden, 1882.
[31]P. Grizou. *Du drainage de l'oeil.* Thèse de Paris, 1877.
[32]Ribard. *Thèse de Paris,* No. 413, 1876, p. 41.

nearly every form of intrabulbar disease it is to be expected that it would be given a trial in retinal separation. It was probably Fano who first (1869) employed iridectomy in the treatment of detachment of the retina. Ten years afterwards[34] he admitted that the operation does not cure the detachment although it sometimes improves vision.

In 1872 Galezowski,[35] thinking that detachment of the retina in myopic eyes bears some analogy to glaucoma, thought iridectomy might exercise a favorable influence on the former disease. His subsequent experience of the operation did not justify its routine practice.

Castaldi[36] advised its employment and reported that of five cases of detachment of the retina following iridocyclitis and iridochoroiditis he was able to effect complete reposition of the membrane in three. Westhoff[37] has confirmed this favorable view of the value of iridectomy in retinal separation following uveitis and reports several successful cases.

In this connection one may quote the statistics of Emil Grosz.[38] Of all reported cases to the date of his paper (1890) *simple puncture of the sclera* failed to bring the least improvement in 44 per cent.; *puncture of the retina* in 65 per cent., and *iridectomy in 66 per cent.*

Coppez[39] quotes Dransart as having obtained by this operation eleven complete reattachments in sixteen cases (!).

Puncture of the Eyeball With the Galvanocautery.

Choroido-retinal Galvanopuncture.

deWecker and Masselon[40] were the first to employ this form of treatment, intended to bring about adhesive inflammation between the choroid and the replaced retina.

The point of the electro-cautery, heated almost to whiteness, is cautiously pressed against that (previously denuded) part of the scleral wall corresponding to the detached area and allowed to burn its way into the sac at the site of punctures previously made with the knife. The cautery point is then immediately withdrawn and the eye treated as after a major operation, with a protective bandage, atropine and rest in bed. If no serious reaction sets in it is repeated as often as necessary.

An instance of complete restoration of the visual field is reported by L. Paton.[41] The sclera was punctured by the *electro-cautery*, the retina being divided through the opening with a Graefe knife. In this instance the detachment involved the lower-outer quadrants of the retina and the scleral openings were made both above and below the tendon of the external rectus.

---

[34]Fano. *Journal d' Oculistique*, Sept., 1879.

[35]Galezowski. Traitement du Decollement de la Retine, par une Operation D'Enclavement de Cette membrane. *Journ. D'Ophtalmologie*, Vol. I, 1872, p. 27, and Decollement de la Retine Se son Traitement per L'Iridectomie, p. 594, of the same journal.

[36]Castaldi. Considerazioni cliniche sulla patogenesi e cura della scollamento della retina. Naples, 1888.

[37]Westhoff. Iridectomic bei Ablatio retinae. Abstract from the Dutch in the *Archiv. f. Augenheilk.*, 21, 1890, p. 150.

[38]*Nagel's Jahresbericht*, XXI, 1890, p. 95. Abstracted from the Hungarian.

[39]Coppez. Du traitement du decollement de la rètine par l' iridectomie. *Bullétins et Memoires de la Soc. Franç.*, 1887, p. 85.

[40]deWecker. Emploi de la Galvano-Caustique (Galvano-Puncture) en Chirurgie Oculaire. *Annales d'Oculistique*, Vol. 87, 1882, p. 39.

[41]Detachment of the Retina Treated by Operation. *Trans. Ophth. Soc. U. K.*, Vol. 28, 1908, p 150.

J. A. Craig[42] reports a case of retinal separation associated with 8 D. of myopia that seems to warrant the employment of this method. Simpler means having failed, scleral puncture was resorted to and reposition of the membrane followed, but it became once more detached in four days. Again scleral puncture was tried, reinforced by galvano-cautery of the sclera. The separated retina now remained in position eight days. Again the sclerotic was punctured and the galcano-cautery applied more vigorously. After this last treatment there was no relapse and twenty months later vision was 6/6.

Wernicke[43] reports upon 422 cases of retinal separation examined in the clinic of Uhthoff, who, by the way, furnishes similar statistics in his paper at the recent Congress in Lisbon. Of this number 36 cases were cured or greatly relieved; 8 were cured by operative treatment, 10 by rest and other minor measures, and 18 got well without treatment. Wernicke is much *in favor of the galvano-cautery*, which, he believes, will best secure extensive adhesions of the retina to the choroid. In the statistics just referred to, in two out of thirteen cases the retina was entirely reattached by the employment of this measure.

Discission of Vitreous Membranes in Connection With Retinal Detachment.

Von Graefe[44] was probably the first to recognize and treat these new formations in the hyaloid body. He understood their interference with vision and their evil action upon the retina. Furthermore, in such cases he did not hesitate to break up the exudates with a discission needle plunged into the eye just in front of the equator.

C. S. Bull[45] has had a large experience in this particular operation. He passes a knife-needle or discission or a heavier needle in front of the equator below the lower border of the rectus externus. The eye must, of course, be free of irritation and the deeper the membrane lies the less dangerous is the operation and the better the results. In 29 such cases Bull had 25 good results.

Bull finds that division of *membranous opacities in the vitreous* causes but little reaction, and may do positive good (even without division of the detached retina), as it reduces the danger of extension of the detachment. It is positively contradicated in cases where the vitreous opacity is vascularized, as it would certainly induce free hemorrhage into the posterior chamber.

Zimmerman[46] reports a case of detachment of the retina following a magnet operation, in which he was able to break up the vitreous exudate in this way. As a result the detached membrane returned to its proper place with marked improvement in vision. He employed a Graefe knife and

---

[42]Craig. Remarks on a Case of Detachment of the Retina. *Br. Med. Journal*, Dec. 23, 1905, p. 1641.

[43]Wernicke. Klinische und experimentelle Beiträge zur operativen Behandlung der Netzhautablösung. *Klin. Monatsbl. f. Augenheilk.*, Feb.-March, 1906, Vol. 44, p. 134.

[44]V. Graefe. Perforation von abgelösten Netahauten und Glaskörpermembrane. *Archiv. f. Ophthalm.*, Vol. 9, p. 85, 1863.

[45]Bull. The Surgical Treatment of Fixed Membraneous Opacities in the Vitreous Humor. *Oph. Review*, 1890, p. 161. See, also, *Trans. Am. Oph. Soc.*, 1894, p. 15, Recent Experiences in the Treatment of Detached Retina.

[46]Zimmerman. Durchschneidung von Glaskörperstränger bei traumatischer Netzhautablösung. *Klin, Monatsbl. f. Augenheilk.*, 1907, 45, p. 192.

passed it through the sclera between the posterior pole of the lens and the opacity. The operation was carried out under observation with the ophthalmoscope.

Abadie[47] has used electrolysis for the dispersion of vitreous opacities. He introduces a platinum-iridium needle 8 mm. long into the depths of the vitreous. The needle is connected with the positive pole of a galvanic battery, the negative electrode being placed on the arm. A stream of three or four milliamperes is applied for five minutes. In a case described by him there was marked improvement in the local condition and in the eyesight.

The Single Vertical or Oblique Incision Through the Sclera.

Wolfe's Operation.

J. R. Wolfe[48] thus describes his operation. He puts the patient under chloroform and introduces the speculum, while the assistant fixes the eyeball with forceps. An obliquely placed slit is made with scissors in the conjunctiva and through the sub-conjunctival tissues, laying bare the sclerotic at a point corresponding to the site of the detachment.

"The lips of the wound are separated by two small [strabismus] hooks, and the assistant steadily maintains the position of the eyeball to prevent the exposed portion of the sclerotic from shifting. The sclerotome is introduced into the sac formed by the fluid. The incision through the sclerotic is made obliquely in such a manner that the edges of the scleral wound should overlap each other and not remain gaping when the instrument is withdrawn. Gentle pressure is made upon the eyeball in the track of the receding lance by means of a fine spatula. The lips of the external wound are brought together with a fine silk ligature or two, and both eyes are strapped with court plaster. The patient is kept in bed in a dark room for three days. The plaster and ligature are removed on the sixth day, and the eye is gradually accustomed to light. On the eighth day the result of the operation may be tested."

The sclerotome referred to is practically a narrow keratome, with rounded angles and a lance-like blade. Wolfe claims that his method differs from a similar operation devised by von Graefe, who directs that "the eyeball be rotated and the puncture made through the conjunctiva, fibrous capsule, and other soft parts, so that the serum is allowed to well out *under the conjunctiva* to be subsequently absorbed; in his [Wolfe's] operation the fluid is withdrawn at once and entirely. The one is an operation done under cover, in the dark, and may prove a miscarriage; my operation is done in open light, and can be managed with more precision."

Extensive Longitudinal Incisions of the Sclera.

Following the example of Wolfe (q. v.), a few operators have advised *several long incisions through the sclera,* not merely for the purpose of draining the subretinal serous fluid, but to produce lasting adhesions between the previously separated retina and the choroid. These radial incisions are first made through the bulbar conjunctiva and then through Tenon's capsule, extending as far as the folds of transmission.

---

[47]Abadie. Désorganication du corps vitré; électrolyse; restitution de la vision. *Annales d'Oculistique,* 114, August, 1895, p. 126.

[48]Wolfe. On an Operation for the Cure of Detachment of the Retina. *The Practitioner, March,* 1883, p. 195.

The globe is fixed with forceps and rotated as far as possible towards the opposite side of the orbit. A Graefe knife, or a small keratome, is passed through the sclera at the border of Tenon's capsule and in a meridional direction as deep as the choroid. It must be borne in mind in this connection that it is well to avoid the horizonal meridian along which the long posterior ciliary arteries run.

In removing the cutting instrument it may be turned somewhat upon its axis to allow the subretinal fluid to drain slowly away. More than one of these incisions may be made in the eyeball, but sometimes a single cut is enough.

As a rule the cut edges of the conjunctival tissues are brought together with one or two silk or catgut sutures, atropine is instilled, a bandage applied to both eyes, and the patient is put to bed for one or two weeks.

Suturing the Separated Retina to the Choroid and Sclera.

In 1889 Galezowski[49] tried the venturesome experiment of suturing, by means of a stout, full-curved needle and catgut, the detached retina to the sclera and choroid. The needle employed had a rounded contour near its eye, flattened towards its point. It was so fashioned that puncture and counter puncture in the sclera were distant about 15 mm. It is only necessary to mention this operation to foresee the failure that awaits the surgeon bold enough to make it, although it certainly is an improvement on de Wecker's gold wire drain, especially as there seems no reason why an adhesive inflammation might not, by the pressure and irritation of the tight catgut thread, bring about a permanent fixture of the errant retina.

Among the accidents in the performance of this operation is the breaking of the needle within the globe. F. Allport (p. c.) witnessed this unfortunate occurrence in the hands of the originator of the procedure, which was followed by panophthalmitis and enucleation of the damaged organ.

In this connection Elschnig[50] informs us that Martin uses in the same way *two silk sutures*, while Evers inserts *a horse-hair* for the same purpose.

Subconjunctival Injections.

Although this method of exhibiting medicaments holds only a minor place among surgical operations so many remedies have in this fashion been employed, and so many surgeons have advised their employment in retinal separation that I am impelled to give a brief review of the literature on the subject. I may, perhaps, add my own experience of subconjunctival injections of 10 per cent. salt solutions in retinal detachment, viz.: that, as an aid to more serious operative intervention they are distinctly valuable and deserve a permanent place in our armamentarium.

The *modus operandi* of subconjunctival injections in detached retina is not fully understood. Whether they act (in virtue of the local irritation) by stimulating absorption of the subretinal fluid, at the same time increasing the watery content of the hyaloid cavity, or whether the process of

[49]Galezowski. Du Décollement De la Rétine et de son Traitement. *Recueil d'ophtalmologie*, p. 1, 1890.

[50]Elschnig. *Augenartzliche Operationen*, II. p. 701.

osmosis (exomosis of the subretinal fluid associated with endosmosis of the subconjunctival solution and pouring out of serum from the ciliary vessels into the vitreous chamber) best accounts for the beneficial results remains to be determined.

It may be mentioned, in passing, that *dionin*, inasmuch as it acts in a manner similar to saline subconjunctival injections, is indicated as a substitute for these agents in the treatment of displaced retina and, in some hands, appears to be of value.

DeWecker,[51] probably influenced by Raehlmann's earlier work,[52] was the first to use this remedy extensively. He injected at first without much effect, simple salt solution into Tenon's capsule but, later,[53] added small proportions of gelatine (3 per cent.) to increase the local irritation and consequent diapedesis of the intraocular fluids. He found the effect on the detachment more marked than before and noticed that the disease of the vitreous was distinctly improved.

In 1896 Lodato[54] gave a favorable account of the use of sodium chloride injections in 15 cases of separation of the retina. In 12 of these there was almost total resposition of the membrane; in two only was there complete failure. The successful cases always showed enlarged visual fields and increase in the central acuity.

During the following two or three years there was, in consequence of continued favorable reports, a widespread employment of this remedy, by Gotti,[55] Mazzoli,[56] Dor, Sr.[57] and others.

Dianoux prefers a mixture of *1 per cent. sodium chloride and 4 per cent. cane sugar* in distilled water. Of this, 4 or 5 cc. are injected into Tenon's capsule on the first, second and fifth day of the treatment. He has found a series of ten such injections to be effective in detached retina.

Dor, Sr., reported at the Ninth International Ophthalmological Congress the results of treatment of 21 cases. Of these, 14 were cured or much improved, several of them having no relapse after four years. His methods included chiefly injections into Tenon's capsule of 20 to 30 per cent. solutions of salt, the application of the Heurteloupe leech to the temple, thermocautery puncture of the sclera at the site of the detachment, a compression bandage and rest in bed.

Bourgeois[58] used subcapsular injections of the following mixture:—glycerine, 10.0, sodium chloride 3.0 and sublimate solution 0.001—without serious reaction. This medication, in ten cases, led to improvement in seven.

Marple[59] has used subconjunctival medication in three cases, but without permanent improvement. He began with 5 per cent. sodium chloride and gradually increased it to 25 per cent., although the stronger solutions were extremely painful.

Guibert[60] tried in three cases the *serum-gelatine of deWecker* and the

---

[51]DeWecker. *Traite complet d' Ophtalmologie, Paris*, 1887.

[52]Raehlmann. Ueber den Daltonismus und die Young'sche Farbentheorie, *Graefe's Archiv. f. Ophthal.*, XXII, 1876, p. 29.

[53]de Wecker. Der heutige Stand der Therapie der Netzhautablösung. *Ophthalm. Klinik*, No. 11, 1899, p. 167.

[54]Lodato. *Archivio di Ottalmologia*, Vol. IV, 1896.

[55]Gotti. *Ancora sulla cura dei distachi della retina*, Bologna, 1898.

[56]Mazzoli. Cenni sul Distacco Retinico E Sua terapia con speciale Rigardo Alle Iniezioni Sotto congiuntivali, *Archivio di Ottalmologia*, Vol. VII, 1900, Jan.-Feb.

[57]Dor. Zur Behandlung der Netzhautablösung. *Zeitschr. f. Augenheilk*, Vol. 2, 1899, p. 29.

[58]Bourgeois. Constitution Du Corps Vitre Comme Point de Dépárt Du Traitement Du Décollement de la Rétine. *Recueil d'Ophtalmologie*, 1897, p. 566.

[59]Marple. On the Treatment of Some Cases of Detachment of the Retina by the Method of Dor. *New York Eye and Ear Inf. Reports*, 1904, p. 15.

[60]Guibert. Décollement de la rétine serum gélatine et sérum de Trunecek. *La Clinique Ophtalmologique*, Sept. 10, 1904, p. 291.

serum of Truneeek with one cure, and temporary improvement in the other two.

Bonté[61] prefers subconjunctival injections of *1 cc. of concentrated solution of sodium chloride with three drops of a 1 per cent. solution of acoine*, repeated at intervals of a few days; complete rest in bed; cauterization of the sclera at a number of points in the region of the detachment; treatment of the cause, myopia, syphilis, etc.

A. Maitland Ramsay[62] has taken all his cases of this condition occuring in hospital practice over a period of four years and reported on the results of treatment by subconjunctival saline injections. The composition of the saline varied in different cases, but the solution ordinarily used was *five to twenty minims of 1 in 2,000 bicyanide of mercury with 8 per cent. chemically pure sodium chloride*. In some cases acoine and, in others, alypin were used as analgesics. Dionine was occasionally added to the injection. Ramsay lays great stress upon the need of attention in every way to the patient's general health, and especially to the state of the bowels during his period in bed.

The average number of injections was five, and the average duration of treatment one month, but prolongation of the period in bed is probably beneficial if the case is one which is improving. On the other hand, if, after fourteen to twenty-one days, there are no signs of improvement, the case may be considered incurable. There were fifty patients treated by this authority, of whom twenty-seven received no benefit whatever. Of the remaining twenty-three, ten showed very decided improvement. Of these ten, five afterwards relapsed, the shortest period being two weeks and the longest four years after conclusion of treatment; of the remaining five, three were satisfactory after one year and two were lost sight of. The other thirteen of the benefited cases showed moderate improvement; some of them relapsed. Ramsay concludes that the favorable cases are few, the unfavorable many; but however hopeless the latter may at first seem, it is always well, before coming to the conclusion that nothing can be done, to try the effect of such simple treatment. It can at least do no harm.

Ramsay gives the following as the formulæ of the various fluids used by him in the subconjunctivical treatment of *amotio retinæ*.

I.

℞

Sodii chloridi (chemically pure), 8 per cent.
Sol. hydrarg. bicyanid., 1 in 2000, 92 per cent.
Misce.

II.

℞

Dionine, 1 per cent.
Sodii chloridi (chem. pure) 8 per cent.
Sol. hydrarg. bicyanid., 1 in 2000, 91 per cent.
Misce.

III.

℞

(Dor's fluid)

Sodii chlorid	grammes	5.
" carb.	"	0.40
" sulphatis	"	0.40
" phos.	"	0.10
Potass. sulphatis	"	0.40
Aq. destillat. ad	"	20.

Misce.

---

[61]Bonté. Traitement du decollement de la rétine. *La Clinique Ophtalmologique*, Jan., 1907, p. 3.

[62]Ramsay. On the Treatment of Detachment of the Retina. *Trans. Oph. Soc. U. K.*, 1906, p. 79.

Staerkle[63] publishes the outcome of subconjunctival injections in 23 instances, with three cures. His conclusions touching this form of treatment are as follows:—

1. The subconjunctival injection of common salt solution forms a harmless and almost painless means of stimulating the absorption of pathologic exudates within the eye.

2. Up to a certain point the stronger the solution the greater the effect. The writer employed three strengths only, 2 per cent., 4 per cent. and 10 per cent., and found these in every way adequate.

3. On the whole, the improvement in the anatomical conditions, as well as in the visual fields and central vision, was more marked as time passed and the injections were continued.

4. The injections had a greater influence on recent, partial detachments than on long-standing and widespread examples of separation of the retina. Intermediate forms were variously affected by the treatment.

Intraocular Injections of Iodine.

Fano[64] was probably the first to propose that an irritant fluid be injected into the sac, combined with simple scleral puncture, "to set up an adhesive inflammation between retina and choroid." Galezowski also has a reference in the first volume (1872) of the *Journal d'Ophtalmologie* to a case in which "iodine injections has been tried without success." It was not, however, until sixteen years later that a definite operation, based on exact pathological findings and animal expermentation, was presented to the profession.

In 1890 my former teacher Schöler[65] reported 26 cases of detached retina in which he had made injections into the posterior chamber of a few drops (2 to 6) of iodine preparations. Permanent reposition of the separated membrane followed in six cases and in two decided relief had been given. In three cases, however, destructive hemorrhage set in, while five others were much worse after than before the injections. In the others temporary improvement was noted. Two patients were treated wtih sodic salicylate injections; one with Lugol's solution.

The choice of iodine preparations followed the author's experiments on animals, which he was led to make because of Leber and Nordensen's researches in the pathology of the disease. He conceived the idea that, since many cases of separated retina result from the formation in a degenerated and shrinking vitreous of fibrils whose tension upon the membrane draw it away from its choroidal bed, this process might be favorably influenced by intravitreous medication. He employed mercuric iodide, sublimate, sodic salicylate and iodine solutions, finally choosing the last as best applicable to human eyes.

In the Schöler instrument the mouth of an ordinary Pravaz syringe is

---

[63]Staerkle. Ein Beitrag zur Therapie der Netzhautablösung. Inaugural. Dissertation, Basel, 1900.

[64]Fano. *Traité des pratiques des Maladies des Yeux*, 1866, p. 417.

[65]Schöler. Zur operativen Behandlung der Netzhautablösung mittelst Jodinjection in den Bulbus, mit Demonstration geheilter Fälle. *Berlin. Klin. Wochenschr.*, 34 and 35, 1890, p. 768-798. See, also, his monograph on the whole subject, *Zur Operativen Behandlung und Heilung der Netzhautablösung*, Berlin, 1889.

fitted with, instead of the usual needle, a small, hollow, gold-plated, platinum tube whose terminal is a narrow knife, pointed and curved like a strabismus hook, the whole being about 4 cm. long and 2mm. in diameter at the middle. The knife itself is 2.5 mm. long and 1.25 mm. wide. At the junction of the small knife with the canula there are two openings about 0.4 mm. in diameter. These indicate two little gutters along the side of the knife that carry the fluid from the syringe into the eye. The cutting end is passed through the scleral wall and the injection follows without the necessity for withdrawing the needle. In small detachments one injection of, say, two drops of the iodine solution, was made in one locality; if extensive, another dose was administered at the antipodes of the first.

In addition to this canula-knife Schöler employed a second terminal in which the canal from the syringe ended on the back of the knife. See Fig. 695.

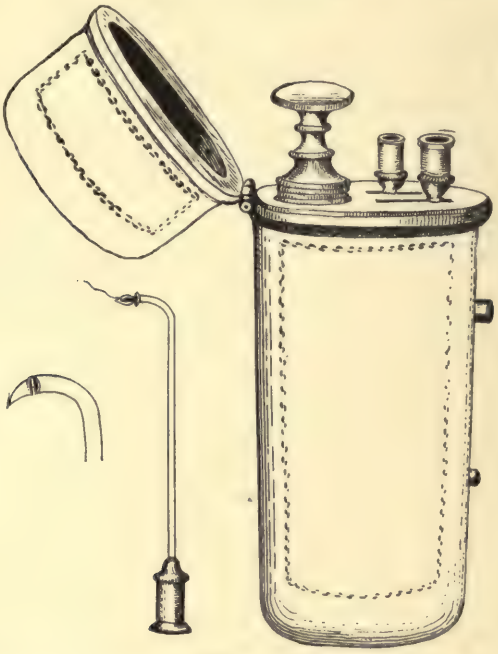


Fig. 695.
Schöler's Instruments for Intraocular Injection.

He operated on some patients sitting; on others in the prone position. Before entering the canula knife the conjunctival and subconjunctival tissues were, after careful disinfection and cocainization, divided with fine scissors so as to allow of easy penetration of the underlying sclera. In the majority of cases from 2 to 4 drops of the tincture of iodine (in two instances 6 drops) were slowly injected. Generally increase of tension and dilation of the pupil followed. The point of the instrument was slowly withdrawn and the wound of entrance was not sutured. The eye was then examined with the opthalmoscope, atropine or hyoscin instilled and a bandage applied for 6 to 8 days.

The pain that followed these injections was most severe just after the operation, but it rarely lasted more than half an hour, then decreased and finally disappeared. In one case only was a hypodermic of morphia needed.

In the literature of this subject will be found descriptions of several modifications of the Schöler instrument for intra-vitreous injection in the treatment of detached retina.

Abadie's syringe, for example, is fully described in the *Archives d' Ophtalmologie*, 1889, page 461.

The rather complicated injection apparatus used by Pflüger, to the form of which he attached considerable importance, is described and pictured as follows by his pupil, Eissen.[66]

The inventor points out the defects of the Schöler instrument—the difficulty of introduction, the considerable force required to pass the large, hook-shaped knife of canula through the sclera (especially if the tension be minus), the uncertainty in estimating the number of drops of the medicament injected and the frequent escape of fluid vitreous and of the solution through the opening after the withdrawal. He believes that these drawbacks greatly diminish the successful chances of the operation and has endeavored to minimize them in his own instrument. This is in the form of a metal Pravaz syringe capable of being sterilized without injury at 200° C. The plunger, graduated to 1/100 c.c., is controlled by a cogged wheel so arranged that by means of the thumb and forefinger, it can be shoved forwards (only) with the greatest accuracy. As represented in Fig. 696, the fine, easily penetrating needle is provided with a small stop-cock, to be turned after the injection and while still *in situ*, to prevent oozing of the intraocular contents.

At the time of the foregoing report the syringe had been used in 12 cases of detached retina without accident, marked pain or untoward result.

Galezowski[67] followed Schöler by directing the injection *into the subretinal space*—with or without the use of his catgut suture.

Abadie[68] made a simple scleral puncture and after allowing some of the fluid to escape injected a few drops of iodine dissolved in a solution of potassic iodide. He had one good result in 10 cases. Dubarry[69] also reports six cases from Abadie's clinic; one was a complete cure; two improved for a short time; two got, or were made worse.

Stedman Bull[70] gives the history of five cases treated by him without a single successful issue, and the loss of sight in one eye from panophthalmitis.

Without boring the reader with the experience of too many observers, Schoenfield[71] sums up the results in 75 cases treated by various surgeons. Of these only three are reported to be complete and permanent cures.

During a year's attendance (1888-89) as Volunteer Assistant in Schöler's klinik I had an opportunity of seeing, with Fischer and Uhthoff, several of the cases mentioned in his report and I can affirm the statement made by Dubarry that while in a very few instances a cure

---

[66]Eissen. Ueber die Technik der Schöler'schen Behandlung der Netzhautablösung. *Illust. Monatsheft der ärzt. Polytechnik*, 3, 1890.

[67]Galezowski. Du traitement du décollement de la rétine. *Archiv. f. Augenheilk.*, 1889, XXI, ref. 481, p. 146.

[68]Abadie. Société Française d'ophtal., May 7, 1890.

[69]Dubarry. Contribution á l'étude du traitement, du décollement de la rétine. Thése de Paris, 1889.

[70]Bull. Operative Treatment of Detachment of the Retina by Schöler's Method; With a Report of 5 cases. *Medical Record*, Jan. 16, 1892, p. 62.

[71]Schoenfield. Beiträge zur Behandlung der Netzhautablösung, Inaug. Dis, 1892.

or permanent improvement followed the use of intraocular injections the total result was disappointing—and that some eyes were probably sacrificed.

Perhaps the report that influenced the profession most strongly against this procedure was that of Gelpke's case[72]—infective purulent uveitis, meningitis and death following a careful injection of three drops of iodine tincture.

Iodine Injections into the Subretinal Sac.

This procedure, as stated, has been recommended by several surgeons, but especially by Fano, Galezowski and Dufour. In cases of retinal separation due to post-retinal fluids, semi-solid exudates, hemorrhage or traumatism this treatment seems not irrational, but in those forms of the disease associated with shrinking of the vitreous or cyclitis, subretinal injections alone can hardly be justified. In any event very few successful cases have been reported as the outcome of this method.

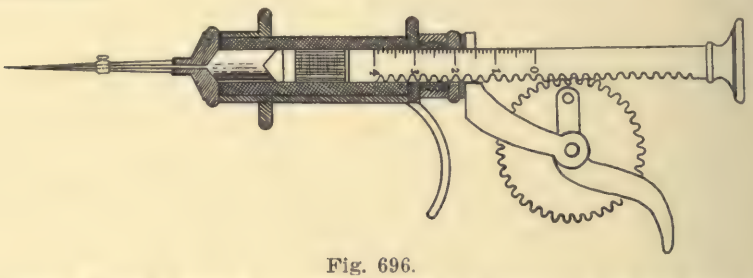


Fig. 696.

Pflüger-Eissen Syringe for Intravitreous Medication in Separation of the Retina.

Electrolysis of the Postretinal Fluid.

Terson[73] employed this method in at least 12 cases and held it superior to any other operative method, especially less dangerous than that of Abadie or Schöler.

The electrolytic needle, made of platinum or platino-iridium, is thrust into the retinal sac through a small opening previously made by scissors and knife through the ocular tunics. It is then connected with the positive pole of a galvanic battery and under a 5 milliampere current the electrolysis is carried on for about one minute.

W. T. Montgomery[74] gives an account of four cases treated by the Ter-

[72]Gelpke. Ein Fall von operativ behandlung Amotio retinae (nach Schöler) mit todtlichem Ausgang. *Centralbl. f. pkt. Augenheilk.*, Sept., 1889. p. 260.

[73]Terson. Quelques considerations sur l'application de l'electrolyse a douze cas de decollement de la retine. *Bulletins et Mem. de la Soc., Franc. d'Ophtal.*, 1895, p. 151.

[74]Montgomery. Electrolysis in the Treatment of Detached Retina. *Medicine*, June, 1896, p. 483.

son method. Positive electrolysis was used. The eye was punctured by a strong platino-iridium needle at the point in the sclera corresponding to the subretinal sac and a current of 5 ma. applied for a minute. The eye was always well cocainized and patients did not complain when the eye was punctured, but as soon as the current was turned on they experienced decided pain. The after-treatment was the use of a 1 per cent. atropine solution, a compression bandage and rest in bed for a week. There was no noticeable reaction in any of the cases. The electrolysis was repeated as often as was considered advisable. In none of the cases was there any improvement whatever, while one of the patients developed glaucoma, which the author thinks was a direct result of the treatment.

Induction of Labor in the Treatment of Ablatio Retinae Due to the Albuminuria of Pregnancy.

This subject is well presented by Allen Greenwood and Edward Williams.[75] They collected and gave a synopsis of the literature in 11 cases which with their own (2) made a total of 13 instances. The majority of the writers quoted advise the induction of abortion or premature labor as the most important element in the conduct of these cases.

Multiple Retino-Choroidal Puncture.

Among the numerous operative procedures for the relief of detached retina advocated by that inventive surgeon, Galezowski,[76] is multiple puncture of the choroid and the separated membrane.

The instrument he employed for the purpose had the shape of an arc of a circle—a stout curved needle—not unlike that he used for the introduction of his catgut suture. A number of punctures and counter-punctures were made in the eyeball, the needle at each insertion passing through the detached retina. In this way he hoped to push or pull the membrane towards the choroid, making a number of retino-choroidal cicatricial points sufficient to keep the replaced retina in its normal position. He reported 17 cases treated in this way, five with partial and two with signal success.

Pagenstecher, according to Scheffels,[77] also used a common steel needle for multiple puncture of the sclera, choroid and detached retina, an operation that was followed by good results.

Elschnig[78] says that Pagenstecher used also a Knapp's knife to make multiple puncture of the sclera, choroid and retina, and that Galezowski tried multipuncture of the sclera and retina in the area of the detachment with a pointed knife which he called his *ophthalmotome*.

August Brűck[79] describes in detail the method of H. Pagenstecher. The post-retinal fluid is drawn away by means of a simple puncture. Afterwards, with a discission needle, four additional sclerotomies are made in the region of the detachment, rather close to one another and through the sclera,

---

[75]Greenwood and Williams. Bilateral Retinal Detachments in the Nephritis of Pregnancy, Boston, 1902.

[76]Galezowski. Du décollement de la rétine et de son traitement par Ophtalmotomie postérieure. *Bulletins et Mem. de la Soc. Française d'Ophtalmologie*, 1895, p. 170.

[77]Scheffels. Heilung Kurzichtiger Netzhautablösung. *Dusseldorf*, 1894.

[78]Elschnig. *Augenärztliche Operationen*, Vol. 2, p. 701.

[79]Brück. Zur Aetiologie und Therapie der Netzhautablösung. Inaug. Dissertation, Munich, 1899, p. 16.

choroid and retina. The post-operative treatment consists in the application of a pressure bandage and complete rest. The essayist gives the results of treatment in several cases and concludes that where multiple puncture with the knife or knife-needle does not bring about a complete cure, it at least prevents a spread of the separation.

Wernicke[80] has shown by experiments on normal rabbits' eyes that scleral punctures do produce adhesions between the retina, choroid and sclera. The question is whether these results are equally effective in detachment of the human retina.

Punctiform Cauterization of the Sclera and Episcleral Tissues.

H. Dor[81] has long been in favor of *punctiform cauterization of the sclera in the neighborhood of the detachment.* In common with others, he believes that the marked irritation set up in the sclerotic tissues brings about an inflammatory adhesion between the replaced retina and the opposed choroid.

Elschnig, in the second edition of Czermak's *"Augenärztliche Operationen,"* gives a complete account of this operation, a part of which I take the liberty of translating.

The sclerotic is exposed by a meridional incision through the conjunctival tissues overlying the scleral coat which, after bleeding has stopped, is punctured at half a dozen or more points with the red-hot galvano-cautery.

This minor operation is done under cocain-adrenalin or, in the case of very sensitive patients, subconjunctival cocain injections may be employed. The conjunctival folds of transmission between two of the straight muscles are taken up with a fixation forceps and slit right to the corneal margin with scissors. The underlying fibres of Tenon's capsule are also cut through, thus making a wound 8 to 12 mm. long.

The edges of the wound are then separated by means of hooks, the eyeball rotated with a fixation forceps in the opposite direction, so that the sclera in the neighborhood of the equator is freely exposed. It is best to hold the wound edges apart with two small [strabismus] hooks—[Stevens' act very well.] It is in the sclera thus exposed that the burned points—five or six are generally sufficient—of the cautery are placed. Care must be taken not to perforate the scleral wall.

Sattler, having placed the *cold cautery point* in the wound, *afterwards* turns on the current until the cauterization is completed.

If, on removing the cautery-point from the wound, it is found adherent to the tissues, the current should be again applied, when it is more easily removed from the charred tissues.

The edges of the conjunctival incision are now brought together with silk or catgut, the wound is dressed and a bandage applied. The sutures may be removed after two days.

The cauterization may be repeated as soon as the eye is once more free of irritation. If, however, the application is too frequently made, there is some danger of one of the straight muscles becoming attached, by scar tissue, to Tenon's capsule.

There can be no doubt, as Wernicke and others have shown, that

---

[80]Wernicke. Klinische und experimentelle Beiträge zur operativen Behandlung der Netzhautablösung. *Klin. Monatsbl. f. Augenheilk.*, 1906, p. 134.

[81]H. Dor. Meine früheren Erfolge in der Behandlung der Netzhautablösung. *Ophthalm. Klinik*, 1907, p. 618. See, also, *loco cit.*, a number of earlier observations on the subject by this surgeon.

this method does induce marked inflammatory adhesions of the retina to the choroid.

H. Dor does not like the electro-puncture, but prefers the *actual cautery* in the form of Guersant's needle, because that instrument is provided with a "stop" which prevents too deep perforation of the sclera. It is heated red-hot in an alcohol flame and applied to the conjunctiva. The objection to this method is that it brings about a marked contraction of the ocular conjunctiva, as well as cicatricial adhesions of the overlying tissues to the sclerotic.

Wessely[82] has exposed the sclera of a patient suffering from exudative detachment of the retina to small *jets of hot steam* directed against the sclera by means of a metallic cylinder. At the point of cauterization a chorioretinitic exudate could be seen.

Elschnig considers the principal value of all these local cauterizations to lie in the fact that the sclera is contracted by the formation of scar tissue in it through these burns, so that *the size of the eyeball itself is reduced.* In other words, galvanic and other forms of cautery bring about the same result that one gets in Mueller's (q. v.) operation. He has employed the cautery in connection with scleral puncture and believes that, in this way, he obtains better results than ordinarily flow from either method alone.

One finds in the literature of this subject many combinations of other methods with galvano-puncture. For example, Deutschmann[83] combined multiform puncture (in ten eyes affected by separation of the retina) with his own operation of *bisection* (q. v.), but he did not find that the cautery punctures contributed much to the favorable result.

Uhthoff employes *cauterization in conjunction with scleral puncture* after which two of the cases so treated were cured. Compared with this result in nine cases, treated by puncture alone, one was healed.

H. Dor[84] reports over 40 cases of retinal detachment in which he made use of a combined treatment, employing the artificial leech, punctiform cauterization and the injection into Tenon's capsule of 10 per cent. sodium chloride solution. Seven of the patients were decidedly improved, five satisfactorily improved and in three there was small improvement. In ten cases there was complete failure.

Deutschmann's Operations.

Bisection, With and Without the Intravitreous Injection of Sterile Animal Vitreous.

In 1895 R. Deutschmann[85] of Hamburg first published his classic description of two operations for which he still claims results unat-

---

[82]Wessely. Internation. Ophthalmol. Congress, 1904.

[83]Deutschmann. Noch einmal "Die Behandlung der Netzhautablösung." *Beiträge zur Augenheilk.*, Part 67, 1907, p. 379.

[84]H. Dor. Des resultats eloignés du traitement du décollement de la rétine. *Bulletins de la Soc. Franç. d'oph.*, 1907, p. 342; consult, also, *Ibid.*, Vol. 13, 1895, p. 181-183.

[85]Deutschmann. Ueber ein neues Heilverfahren bei Netzhautablösung. *Beiträge zur Augenhlk*, part 20.

tained by any other form of treatment. He is opposed to waiting until non-operative measures have been tried, but advises us to proceed at once to the more effective employment of surgical intervention. The simpler *bisection* (*"Durchschneidung"*) method he regards as especially valuable in the more acute or recent cases; the *combined* procedure he reserves for the advanced and less hopeful forms of the disease.

Deutschmann claims that "bisection" reduces the tension on the shrunken retina, which in his experience may be so marked that it is impossible to reattach it without making one or more incisions in the region of the ora serrata. He not only evacuates the subretinal and preretinal fluids but tries to produce small inflammatory or exudative adhesions between choroid and retina. With the injection of animal vitreous into the posterior chamber he produces a mechanical pressure on the detached retina against the choroid, and a welding of both membranes on an inflammatory basis, with simultaneous re-filling of the eyeball. Relapses may occur with either or both methods, but under these circumstances he repeats the operations in an attempt to regain what has been lost.

The author refers to the favorable statistics of Horstmann (6.66 per cent. of cures), and Uhthoff (16.10 per cent.), as the result of operative interference, but believes that much better success can be attained by his methods. As evidence he gives his own experience. To July 1, 1909, he has operated on 302 cases of retinal detachment, the treatment being concluded in 267 instances. Of these he *cured* 70, or 26.1 per cent., *improved* 94 or 35.2 per cent., *failed* in 103 or 38.7 per cent. From these totals, however, he subtracts a number of cases *on whom the operation was performed as an experiment, without the least chance of recovery of sight* (the patients fully understanding the situation) with these results: *cured* 31.1 per cent.; *improved* 41.3; *not cured* 27.6 per cent.

Karl Grossmann† treated three cases of detachment of the retina by intravitreous injections of a saline solution, using an ordinary hypodermic syringe for the purpose. After withdrawal, by means of the same syringe, of the *postretinal* fluid, the needle being passed through the globe, about ⅜ of an inch from the corneal margin, he slowly injected about 5 drops of a warm ¾% common salt solution into the vitreous. There was little reaction and reattachment of the retina followed completely in one case, partially in the other two.

---

*I am much indebted to Prof. Deutschmann not only for reading the proof of this section but also for several original drawings illustrating his operations.

†Grossmann. On the Mechanical Treatment of Detached Retina. *Ophthal. Review*, 1883, p. 289.

Bisection of the Vitreous and Retina.

This operation[86] is never employed in cases where the detachment is above the equator; when one has to deal with such it is better to wait, *without treating the patient*, until the subretinal fluid has gravitated downwards.

After thorough disinfection and cocainization a two-edged, linear knife about the width of a medium-sized Graefe, is entered at a tangent to the globe (through conjunctiva and sclera well back of the ciliary region), passed quickly forward and then downward and backward, sweeping towards a counter-puncture at the other extremity of the ocular diameter, so as to "cut in two" as much as possible of the vitreous chamber without wounding any surgically important structure. The point of the knife should penetrate the sclera and lift up the overlying conjunctiva but should not pierce the latter. Draw the knife out as quickly as it was entered, turning it a little on its axis so as to allow the subretinal as well as some of the preretinal fluid to escape.

This manœuvre may be repeated as often as twenty times or more, with sufficiently long intervals between successive operations to permit the eye to recover from the reaction, which, however, is generally small or *nil*.

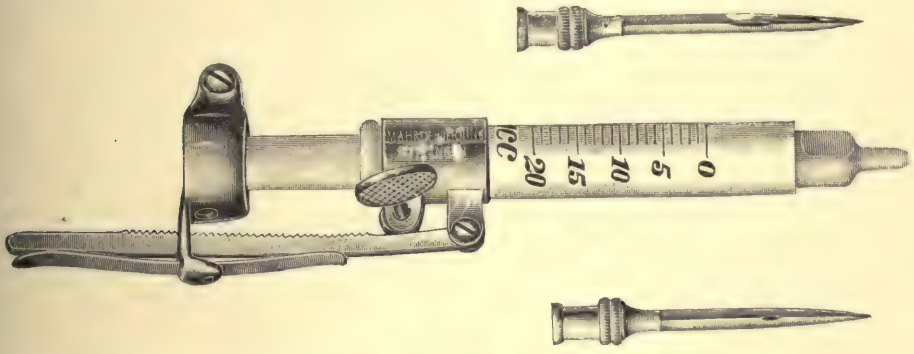


Fig. 697.

Deutschmann's Syringe (canula-knife) for Intravitreous Injections.

Of course this interval must be a longer one if one of the larger retinal vessels has been wounded, or any other unforseen accident should occur. A celluloid shield should then be applied to both eyes or if a bandage be used, it should be a *loose* one for the first 24 hours. After the first day cover only the eye operated on, which must be kept under the influence of atropine during the whole period. Keep the patient in bed for 7 or 8 days after each operation and watch results with the ophthalmoscope.

As a rule, when these directions are strictly followed under careful asepsis, the operation is without danger to the eye.

Combined Bisection and Intravitreous Injection of Animal Vitreous.

Deutschmann reserves this operation for those cases in which vision has sunk very low or where other means of restoring sight have failed. He says that while one must not expect too much from it, yet by its

---

[86]Deutschmann. Weitere Mitteilungen über mein Heilverfahren bei Netzhautablösung. *Beitrage zur Augenheilkunde*, Heft 59, 1904. See, also, The Treatment of Detachment of the Retina, *The Ophthalmoscope*, Aug., 1907, p. 410.

use he has been able to save a small percentage of eyes in desperate cases. He also claims that, carried out under full cocainization and with strict aseptic precautions, it does not endanger either the eye operated on or the fellow eye. The pupil should be fully under the influence of atropine.

The instrument employed by Deutschmann (glass syringe), to use the author's words, is "made by the firm of Mahrt & Hörning, of Göttingen, and allows only an advance forward of its piston. This arrangement is provided so that no deleterious *suction* can be practised upon the contents of the eye should the finger by chance be removed from the piston end. As nozzle for the syringe one may employ either a platinum-iridium canula, or a double-edged knife canula. The latter is also made by the firm above mentioned under the name "*Kanülen Messer*"—"canula-knife." Deutschmann now employs the ready-to-use, sterilized vitreous body of absolutely fresh calf's eyes, hermetically sealed in glass tubes. These are supplied by Dr. W. Mielck, Dammthor-Strasse, Hamburg. This chemist supplies two kinds of calf's vitreous: No. 1, made by the filtration of freshly-boiled vitreous body, afterwards re-sterlized by boiling in hermetically-sealed glass tubes. This preparation has a weaker action than No. 2, which is composed of fresh vitreous body inspissated at 40 degrees Cent. *in vacuo*, and the residuum

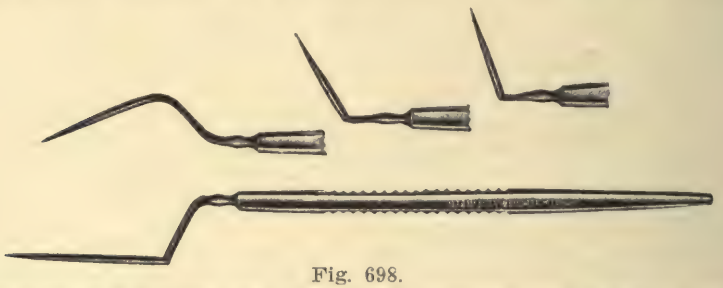


Fig. 698.

Deutschmann's Knives for the Bisection Operation in Detached Retina.

taken up with physiological salt solution—sterlized by boiling—so that the component parts of normal but concentrated vitreous body are contained in it.

The *technique* of this intravitreous operation as given by the author is as follows: "To bring the retina once more as close as possible to the choroid by means of the pressure of the injected animal vitreous it is, of course, necessary to get rid of the subretinal fluid. If one uses the point of the ordinary platinum-iridium canula then the procedure is as follows: The syringe, filled with the animal vitreous, is best introduced in the region of the *ora serrata*, somewhat outwards and downwards. It is given to the assistant to hold while the operator, with the double-edged linear-knife, makes the usual simple bisection downwards. After the completion of this manœuvre, he, with the syringe, injects into the eye *very slowly* some of the contents of the barrel. It is generally sufficient to push forward the piston 1.50 to 2 divisions, according to the consistency of the eye. Then, the syringe point is withdrawn and the puncture closed with toothed forceps for some minutes, that none of the fluid injected may escape from the eye. To use the *syringe with the canula-knife*, omit the usual bisection and insert knife point of the syringe, filled with animal vitreous, in exactly the same way as is directed in the bisection operation with the double-edged knife. One may introduce the canula-knife up to the point of the counter-puncture but in all cases *avoid moving the point from side to side.*

On the introduction of the syringe the subretinal fluid flows out. Then

one immediately presses the syringe piston forward, thus making the injection. The point of entrance is in this case also held together with forceps after the removal of the syringe.

After the operation both eyes are lightly bandaged for 24 hours, then one eye only. Further measures depend upon the reaction shown by the eye. This reaction, again, is dependent upon the concentration of the animal vitreous used. "I must here state that to spare my colleagues every unpleasant experience, they must *begin with the weaker preparation*, and, since the operation can with perfect safety be repeated several times, gradually go on to stronger ones.

These injections demonstrate that the reaction of the eye becomes reduced with each use of the remedy."

For the first injection one should dilute vitreous preparation No. 1 with equal parts of sterilized physiological salt solution; for the sec-

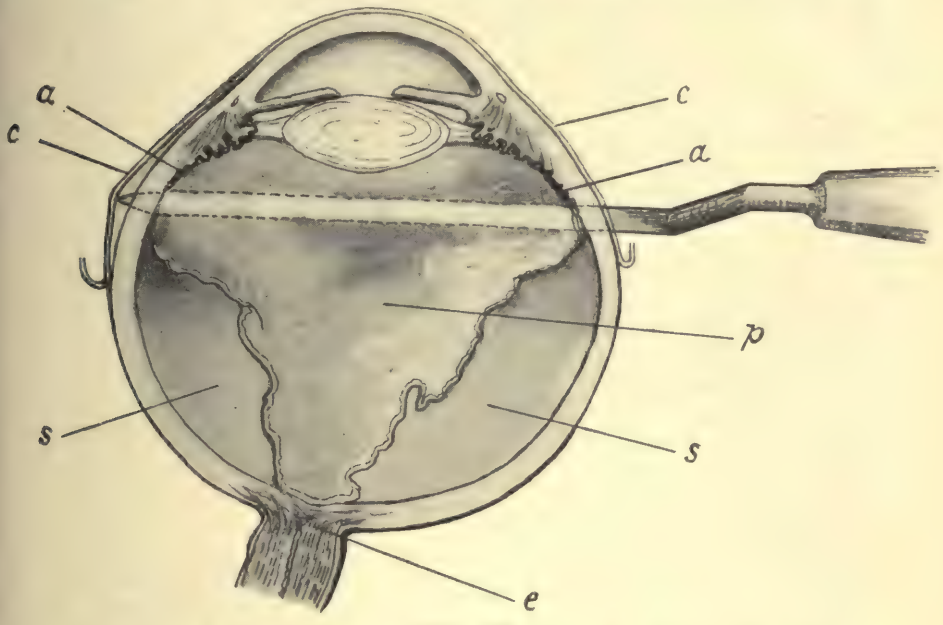


Fig. 699.

Deutschmann's Bisection Operation for Detached Retina. The direction of the knife in typical cases. *a*, Ora serrata. *p*, Preretinal space with Preretinal fluid. *s*, Subretinal space with Subretinal fluid. *c*, Conjunctiva. *e*, Optic nerve-head.

ond use the solution pure, and so on. Inflammatory symptoms, such as may appear at various periods up to the eighth day after the operation are, as a rule, easily controlled by atropine and hot applications. "If increase of tension set in, one should at first wait quietly; only when the pain becomes very severe, and perception of light is somewhat worse under the influence of the heightened tension should one interfere and do another simpler bisection." It should always be borne in mind that after every injection the vitreous body will be-

come more or less cloudy. This translucency gradually clears up completely. Even if it assumes a yellowish, abscess-like appearance it becomes clear and normally transparent again in the course of a few months. It is only now and then necessary to assist absorption by hot applications or by an occasional salt injection.

The author's latest statistics[87] report 68 eyes treated by the use of animal vitreous. With repeated injections he cured 3 cases, improved 26, failed in 38 and 1 is still under treatment.

Since the publication of Deutschmann's first paper I have done

Fig. 700.
Deutschmann's Bisection Operation.

the bisection operation on 10 eyes in 9 cases. Of these there was complete re-attachment of the retina with restitution of useful vision (Jaeger 1 and 20/30) in one instance. This improvement continued for over three years—as long as the case was under my observation. In two others decided improvement of central vision followed, but with incomplete reattachment of the retina. In the others there was little or no improvement.

[87]Duetschmann. On the Treatment of Detachment of the Retina, *The Ophthalmoscope*, Nov. 1909, p. 737.

I cannot understand why Deutschmann refrains from giving patients the benefit of the milder, non-operative forms of treatment (known to bring about occasional cures) *while waiting for the gravitation of the subretinal fluid* to lower levels. When the detachment in the upper quadrants is not due to malignant tumor or other incurable cause I am in the habit of making a thorough inquiry into the probable cause of the separation and with rest in bed, pilocarpine sweats, iodides, subconjunctival injections and the use of other means more or less rational, endeavor to bring about some alleviation of the patient's symptoms.

Deutschmann[88] believes that a hemorrhage occurring between the choroid and retina assists rather than hinders the subsequent inflammatory adhesions between the two tunics.

Mueller's Operation.

Resection of a Portion of the Scleral Wall.

The originator of this operation, Leopold Mueller,[89] was led to perform it because of his belief that many cases of detachment are due to the *disproportion between the shrunken or shrinking vitreous humor and the ocular envelopes.* He proposes a rather formidable but, he claims, successful remedy for this condition, no less than an attempt to reduce the size of the eyeball.

Since it is impossible to attain asepsis of the conjunctiva, Müller operates on the globe behind the equator.

Krönlein's resection of the temporal orbital wall (q. v.) *forms the first stage of this new operation.*

The technique is as follows:—the Krönlein resection done, the temporal aspect of the eyeball is thoroughly exposed. The external rectus is then divided, the cut ends being secured by fine sutures, so that they may be later reunited.

The operator now carefully and slowly excises with a sharp scalpel a bi-convex piece of sclera 20 mm. long (with its length parallel to the equator), and 8 to 10 mm. wide, in such a manner that its anterior edge lies 1 or 2 mm. behind the insertion of the external rectus. Its posterior margin should correspond to the equator. The edges of the scleral wound are now brought together by five small stitches.

In the performance of this operation care must be taken not to injure the choroid, but, just before tying the scleral sutures, the subretinal sac is tapped with a narrow knife and some of the fluid allowed to escape. The cut ends of the externus are now carefully approximated and the bony plate, skin, etc., readjusted. When the wound is closed the whole eyeball is smaller than before.

Mueller reports three cases in which he had done this operation, after which the separated membrane resumed and held its proper position for 10, 11 and 15 months respectively.

It is, of course, too soon to pass judgment on this operation.

---

[88]Deutschmann. Weitere Mitteilungen über mein Heilverfahren, *Beiträge zur Augenheilk.*, Part 59, 1904.

[89]Müller. Eine neue operative Behandlung der Netzhautabhebung. *Klin. Monatsbl. f. Augenheilk.*, May-June, 1903, p. 459.

Perhaps, in the majority of cases—those associated with the enlarged globe of extreme myopia—it may prove more valuable than any other operative procedure.

Lang's Operation.

Maser's Operation.

The object of this surgical measure is to make an irregular or ragged wound in the retina, as well as to evacuate the subretinal fluid.

A Graefe knife is passed through the ocular wall into the retinal sac. It is then turned at right angles, a retinal discission made and the knife withdrawn. In this way it is hoped that the ragged wound in the sclera-choroid and the retina may heal together. G. W. Maser[99] reports the treatment of a case by this method. Reattachment took place and continued to be complete three months after the operation.

The technique of the operation is as follows:—a triangular flap is made in the conjunctiva over the sac-area, preferably between the attachments of two straight muscles. After the hemorrhage has ceased a thin Graefe knife is pushed through the sclera, choroid and retina well into the posterior chamber. The knife is now turned at right angles to the wound of entrance and the serous fluid is allowed to escape. The retina is now further incised at right angles to the first incision. Considerable reaction follows this method. After the operation he bandages both eyes, puts the patient to bed and keeps him in the recumbent position for a week or more. A series of these posterior sclerotomies with extensive incisions of the retina are made at proper intervals until complete reposition of the retina is established.

The difference between this operation and that of von Graefe is that Lang does his dislaceration after puncturing the sac, while Graefe approached the detached retina in front of the sac. In other words, the operator does with a thin knife what Bowman attempted with two needles—to bring about a jagged wound and to set up a decided adhesive inflammation in the retina thereby.

Other Surgical Procedures.

The long list of operations and remedies described or mentioned in the previous pages of this chapter might be extended if it were at all profitable to give space to such measures as appear to have little or no claim upon our attention. I have, for example, refrained from speaking of *setons, blisters* and *leeches* because these adjuncts to operative treatment belong to a past era in surgery. *Discission of the transparent lens* does not seem a rational proceeding and, for that matter, has few serious advocates. For information regarding such refinements of surgery as *sclero-dictyotomy* (see the *Thése de Paris* of Debierre, No. 264, 1881, p. 633) *injections of air into the hyaloid cavity, operations on the neighboring cavities* (*vide* Fish, *Ophthalmic*

[99]Maser. A Case of Detached Retina. *Jour. Kas. Med. Society*, July, 1905, p. 279.

Record, June, 1904), the application of *galvanism* or of the *faradic current,* etc., I would refer the reader to the rather sparse literature on these subjects.

Summary.

One who has made a study of the observations of others in the surgical treatment of detached retina and has added to it his own experience—though that may be limited—will, I think, come to these conclusions:

1. Inasmuch as separation of the retina is not a distinct disease but merely one sign—albeit a very important one—of several different affections, it is not to be expected that it is to be cured or much relieved in every instance by some particular operation. The "one-disease-one-operation" idea can have no place here.

2. A large percentage of retinal repositions, including an unknown proportion of those that follow operative measures, belongs to the class of "spontaneous cures." In such cases relief may have been assisted, hastened or rendered more or less permanent by the remedies exhibited, but the probability is that the patients would have recovered in any event.

3. So far as prognosis is concerned, the more hopeful cases are the recent, limited varieties—those produced by traumatism, post-retinal hemorrhage and the like—as well as those resulting from removable causes. *Per contra,* old, extensive detachments, especially when associated with marked degeneration of the retina, vitreous and choroid, are not likely to get well under any forms of treatment. A long-separated, starved retina rarely regains its lost functions.

4. Recurrence of the detachment forms a disappointing feature in the treatment of the disease and this fact should be considered by both patient and surgeon when the subject of operation is broached. On the other hand, it has been abundantly demonstrated that cases of separated retina have recovered after several relapses and after the patient has submitted to many operations.

5. No case should be regarded as permanently cured until at least a year after the replacement of the detached membrane. It is true that relapses are recorded after an interval of several years, but they are unusual.

6. When a patient presents himself it is best to try for, say, a month—indefinitely as long as improvement continues—non-operative measures. A thorough study should be made of the case to determine. subconjunctival injections, instil atropia and keep the patient in bed. Pilocarpine sweats, with iodides or sodic salicylate, are also generally indicated.

7. Failing to improve vision or to replace the separated retina by milder means, resort should be had to operation and the question of the *best operation for the case in hand* at once arises. We know that the function of the retina gradually weakens the longer it is displaced, consequently, the sooner one makes a choice of operation the better.

8. Deutschmann advises against his operations as long as the postretinal fluid is held within the upper quadrants of the globe. If we are debarred by this circumstance from the use of his methods, there can be no objection to the employment of scleral puncture, combined with punctiform cautery of the denuded sclera over the site of the detachment. Why should we wait until the retina is further detached and degenerated?

9. In those cases where the sac occupies, as it generally does, the lower aspect of the hyaloid chamber, Deutschmann's method of *bisection* should be the operation of election, whether or not there be evident rents in the retina or visible fibrillæ in the vitreous.

10. Two weeks after an intrabulbar operation a careful examination of the eye should be made—with the electric ophthalmoscope (so that the patient may keep the prone position), hand perimeter, ward charts, etc.—to decided if improvement has taken place in the local conditions as well as in central and peripheral vision.

11. Assuming the eye to have recovered from any operative measure, *i. e.*, to be free from either intra- or extraocular inflammation, the same or another operation may be done in from three to six weeks' time.

12. In unpromising cases Deutschmann's intraocular injection of animal vitreous is in order, although Mueller's exsection of the sclera seems a rational though formidable procedure, which an improved technique and a wider experience may yet demonstrate to be of great value in the conduct of this extremely serious condition.

EMBOLISM OF THE CENTRAL ARTERY OF THE RETINA.

As is well known, an embolus derived from vegetations on the valves in cardiac diseases, or from deposits on or within the intima in arteriosclerosis, aneurism or other disease of the vascular walls, may lodge within the trunk or any of the branches of the central artery. Sudden, partial or complete blindness in the affected eye may follow and, as a rule, treatment of such a case—especially surgical intervention—is not of much avail.

Operative Measures in General.

I have done an *iridectomy* both in recent and in older cases and

my experience of it has been elsewhere reported.[91] I have since then employed *iridectomy* (q. v.), *paracentesis carneæ* (q. v.) and *paracentesis sclerœ* (q. v.), but without noteworthy improvement except in the case of the first named procedure.

It is not, however, to be supposed that because a disease does not readily respond to treatment that one should neglect all therapeutic measures. Yet a good deal may be said in favor of the *laissez faire* policy in many, if not most of the examples of retinal embolism that come under one's notice. The fact that not a few cases of partial and even of total embolism have recovered without any treatment at all, may well give rise to the suspicion that some at least of the reported recoveries might have occurred without active interference, and that the happy issue was due to an accidental dislodgement of the plug or to the disintegration, or absorption of an imperfectly organized embolus. Having had an experience of some half dozen cases in which all of the ordinary and some extraordinary measures were adopted. I append the headings of the case histories:

Case I.—At first total (?), subsequently partial, embolism; embolus visible; *recovery without treatment;* cardiac disease.

Case II.—Partial embolism in an apparently healthy subject; *deep ocular massage and iridectomy;* gradual improvement in central vision and extension of the field.

Case III.—Total embolism of the left artery; organic disease of the heart; retention of a small island of precipient retina; *treatment by deep massage with slight improvement.*

Case IV.—Total embolism in a healthy woman; *massage and narrow iridectomy;* some improvement in vision.

Case V.—Total embolism in a patient subject to chronic cardiac disease; preservation of partial vision by cilio-retinal vessels; *treatment of slight avail.*

As previously stated, a fact that must always be reckoned with in estimating the value of any remedial measure for retinal embolism is the tendency of almost every case to improve, with or without treatment. The instances are exceedingly rare where, either in total embolism or in obstruction of the larger branches of the central artery, *no* blood circulates through the vessels. There is usually some retinal area that, as a result of a partial blood supply, survives and functionates after it has passed through the initial stage of edema and strangulation, even if it be eventually destroyed as the result of atrophy of the nerve itself. Such functionating retinal oases or sectors increase in area because of the extension of these reviving areas. The nutrition of the retinal strip that bounds the margin of the defect is not so entirely cut off from its proper nutrition as are the

[91]Casey Wood. A Contribution to the Treatment of Embolism of the Central Artery of the Retina, *Ophthalmic Record*, June, 1899, pp. 272-285.

central portions. When the edema subsides this partially affected border recovers and vision is improved.

The extent of the damage and the possibility of its repair also *depend upon the position and character of the embolus.* If this be a solid, fibrous plug, caught at the bifurcation of a vessel, it will not entirely block the passage of blood, and the final effect upon the area supplied by it will be less disastrous than if the embolus be of softer material and, adapting itself exactly to the lumen of the vessel, completely shut off the blood stream.

Another chance of improvement in vision apart from treatment, hangs upon the possible absorption of the plug. Several autopsies have shown that the embolus has entirely disappeared within a comparatively short time. Should the embolus undergo even a partial absorption before destructive secondary changes in the obstructed vessels, optic nerve and percipient elements of the retina declare themselves, it is easy to understand that, with a return of the nutritive supply, the less injured parts of the retina will once more resume their lost function.

Iridectomy, Sclerotomy and Paracentesis Corneae in Retinal Embolism.

So far as *iridectomy* is concerned—with it as a remedy one may include *sclerotomy* and *paracentesis corneæ*—for the sake of a sudden reduction of the intraocular tension, it seems as rational now as it did to Graefe in 1859. If the caliber of the obstructed vessel be increased even for a few days after the critical moment of the embolism, it is surely to be desired.

Amyl nitrite inhalations, as suggested by Harold Gifford[92] might well be employed either alone or as an adjunct to iridectomy, paracentesis or *massage.*

The reputation of the last named remedy rests upon a few successful cases. One cannot, however, read Fischer's[93] monograph, or accounts of similar cases, without wondering what became of the embolus, exactly how it was affected by the massage of the eyeball, and what would have happened had nothing been done. As long as it retains its form and solidity one can imagine no escape for the embolus. Its effect as an obstruction continues even if, as Fischer supposed, the operation of massage produce a return current (producing a *vis a fronte*) that thrusts back the valve-like embolus, allowing for an instant a side stream of blood to flow to the impoverished retina. Com-

[92]Gifford. Embolus of a Branch of the Retinal Artery Visible with the Ophthalmoscope, Disappearance of the Embolus and Nearly Complete Recovery Under Massage and Nitrite of Amyl. *Jour. Am. Med. Ass'n.* April 12, 1890. Gifford in this paper awards priority to Jessop.

[93]Fischer. *Ueber die Embolie der arteria centralis retinæ.* Leipzig, 1891.

plete recovery, after dislodgement of the plug, demands its early absorption after it has been broken up into minute fragments and so carried to the finest retinal arterioles.

In all probability there are in many eyes cilioretinal anastomoses apart from the vessels so commonly visible at the disc. Why should we not have similar anastomoses in other parts of the fundus? May not the existence of peripheral retinal oases (pictured by many writers) in the blind areas of embolism oe thus explained?

As to the *effects of deep massage upon the damaged eye,* in two of my cases where this remedy was employed the globe became decidedly tender and scleral congestion was evident after two or three minutes' steady pressure. In one of them the embolism had been preceded and followed by pain and soreness in and about the eyeball, and doubtless the irritability of the structures had much to do with the tenderness after massage.

I do not believe that, with the majority of American patients at least, it is possible to keep up effective kneading of the globe for more than two or three minutes at a time, and it seems more rational to accomplish this three or four times daily than to continue the massage half an hour once a day.

Instructive papers on the treatment of this serious condition have been published by Würdemann,[94] Barkan,[95] de Schweinitz,[96], S. C. Ayres,[97] and many others.

---

[94]Wurdemann. The Treatment of Recent Embolism of the Retinal Artery by Deep Massage, with Report of Two Cases Cured by this Method. *Annals of Ophth.*, Oct., 1901, p. 582. Also, The Treatment of Recent Embolism of the Retinal Arteries by Digital Massage. *Amer. Journ. Ophthalm.*, Jan., 1906, p. 1.

[95]Barkan. Case of Embolism of a Branch of the Central Retinal Artery Treated with Forcible Massage. Recovery. *Archives of Ophthalmology*, Vol. 31, No. I, 1902.

[96]deSchweinitz. Embolism of the Central Artery of the Retina with Report of Three Cases. *Jour. Am. Med. Ass'n*, Sept. 24, 1892, p. 357.

[97]Ayres. Embolism of the Central Artery with Report of a Case. *Jour. Am. Med. Ass'n*, Aug. 27, 1892, p. 335.

CHAPTER XIII.

VARIETIES OF BLEPHAROPLASTY. OPERATIONS FOR ECTROPION, CANTHOPLASTY, TARSORRHAPHY AND FOR RESTORATION OF THE CUL-DE-SACS.

By CHARLES H. BEARD, M. D., Chicago.

Surgical Anatomy of the Eyelids—The Superciliary Muscles—The Palpebral Muscles—The Surgical Anatomy of the Conjunctiva—Canthoplasty—The von Ammon-Agnew Operation—Tarsorrhaphy—Walther's Operation of Tarsorrhaphy—Fuchs' Tarsorrhaphy—Arlt's Internal Tarsorrhaphy—The Bowman-Panas Operation of Median Tarsorrhaphy—Bossalino's Tarsorrhaphy—Total Tarsorrhaphy—Classification of Methods in Skin Grafting—General Considerations—Choice of Plastic Operation—Preparation for Plastic Operation On the Lids—Reverdin's Method of Skin Grafting—The Thiersch Graft in Blepharoplasty—The Wolfe Graft in Plastic Surgery of the Eyelids—Operation for Spastic and Mechanical Ectropion—The Snellen Suture in Ectropion—Ziegler's Operation for Slight Ectropion—Argyll-Robertson Operation for Ectropion—Fox's Operation for Ectropion—Operations for Atonic Ectropion—Adams' Operation for Atonic Ectropion—The von Ammon Operation—Kuhnt's Operation for Atonic Ectropion—Beard's Operation for Atonic Ectropion—Dieffenbach's Operation for Atonic Ectropion—Operations for Cicatricial Ectropion—Dieffenbach's Operation for Cicatricial Ectropion—The Wharton Jones' Operation for Cicatricial Ectropion— Graefe's Operation for Cicatricial Ectropion—Jaeger's Operation for Ectropion of the Upper Lid—Dieffenbach's Blepharoplasty—The Kuhnt-Szymanowski Operation—Harlan's Operation for Ectropion—Czermak's Modification of Dieffenbach's Operation—Burow's Operation for Ectropion—Von Ammon's Operation—Hotz's Blepharoplasty in Ectropion—Tweedy's Operation for Ectropion—Denonvilliers' Operation—Argyll-Robertson's Strap Operation for Ectropion—The Kuhnt Operation for Ectropion—Helmbold—Kenneth Scott's Operation for Ectropion—Snydacker's Method of Autoplasty—The Indian Method. Transplantation of Pedunculated Flaps—Blasius' Operation for Restoring a Lid—Hasner's Blepharoplasty—Blepharoplasty by Means of Double Pedicled Flaps—The Italian Method. Heteroplasty—Berger's Modification of the Italian Method—Blepharoplasty for the Restoration of a Portion or of the Entire Eyelid—Goyanes' Operation for Restoration of the Eye-brow—

Operations for the Relief of Symblepharon—Definition—Etiology —Arit's Operation for Symblepharon — Teale's Operation for Symblepharon—The Teale-Knapp Operation for Symblepharon—Himly's Symblepharon Operation—Harlan's Operation for Symblepharon—The Panas Operation for Symblepharon—Thiersch Grafts in Extensive or Total Symblepharon—Czermak's Operation in Extensive Symblepharon —The Hotz Operation for the Restoration of the Cul-de-Sacs—Weeks' Operation for Cicatricial Orbit.

Surgical Anatomy of the Eyelids.

Plastic surgery of the lids is concerned chiefly with the palpebral and superciliary regions and the skin immediately surrounding them. Within this area are several lines of considerable surgical interest, because incisions which follow natural curves or wrinkles produce a minimum of scarring and these lines may frequently be advantageously followed in lid operations. Above the brow are two or more corrugations especially well marked in some individuals, while at the upper and lower boundaries of the orbit and at the convex borders of the tarsi are certain more or less pronounced furrows or sulci. Below the orbit is a curved line, or lines, extending from the inner canthus downward and outward over the cheek. These lines on the cheek are scarcely discernible in the young or robust but are usually well marked in the corpulent, the emaciated and the aged.

The *eyebrows,* or *supercilia,* which consist of a ridge of prominent, thickened integument supporting short, thick obliquely placed hairs, frequently demand attention, either as an obstacle to bringing a pedicled graft down from the forehead, or as a possible substitute for eyelashes.

The hairs of the upper half of the eyebrow point downward, and those of the lower half point upward; hence the lower half seems well suited for replacing the cilia of the upper lid, and the upper half for a like substitution as regards the lower lid, as they thus most nearly approximate the natural curve of the lashes. This is theoretically correct and generally true in a practical sense. The obliquity of their direction, however, renders it impossible for them to have the same position as the normal cilia, and there is apt to be an interlacing of the upper and lower lashes when the eyes are closed. This interlocking will cause constant disarrangement of the cilia, some of which will probably rub the cornea, and cause irritation of the eye.

In old age the supercilia frequently become quite coarse and long, especially in old men. For this reason the substitution of eyebrows for cilia is a more favorable operation for women than for men, though it has been the author's good fortune to restore the whole of the upper lid and cul-de-sac by a sliding flap from the forehead, whose lower

margin included a row of the uppermost supercilia, which admirably simulated cilia when slid into place.

In this case the globe and entire lid had been destroyed by a burn from contact with a large electric main. A pedicled flap was fashioned from the forehead, base out, in such a way that its lower edge included a thin strip of the upper part of the supercilia. Especial care was taken to leave the attachment of the remainder of the superciliary ridge undisturbed, as it was to be used as an anchorage for the sliding flap that was to cover the defect produced by the operation, as well as to furnish attachment for the new lid. The pedicled flap was turned into the position of the missing lid and sutured to the lower border of the superciliary ridge. The defect left by the flap was covered by freely undermining the skin above it over the forehead and well up into the hair. This skin was then pulled down and sutured to the superciliary ridge. To avoid tension strips of adhesive plaster were used to draw the skin of the forehead well down and hold it in position until a firm union was established. To restore the cul-de-sac a second operation was performed in which the scar tissue in the orbit was freely incised so as to produce a cavity resembling a normal socket, and upon this raw surface and the raw, inner side of the lid were placed Thiersch grafts held in place by a paraffin-coated lead plate. The result was highly gratifying. The patient wears a prothesis with comfort and good cosmetic effect. The latter is enhanced by the narrow strip of supercilia which lies along the lower border of the restored lid and very closely resemble normal cilia.

The Superciliary Muscles.

The eye-brows are connected with the *orbicularis, corrugator supercilii* and *occipito- frontalis* muscles; hence all operations depending upon the action of the occipito-frontalis for the elevation of the lid will inevitably produce a certain amount of disfigurement by also elevating the brow. Certain operations for ptosis are lame in this particular.

The *integument* in the neighborhood of the upper, lower and outer regions of the lids is so lax that the eye may be closed by tension in the direction of the outer canthus. On account of this fact too much tension at this point should be avoided, although the dangers of horizontal tension are slight compared to those of vertical tension which, even if of only a small degree, produces ectropion. At the side of the nose the skin is more adherent than elsewhere, hence it forms a firm anchorage for grafts whose tension is outward. The skin under the upper border of the orbit is thinner than that of the supraorbital region and forms a deep fold where it turns over the border of the tarsus. Allowance for this fold must be made in using thick skin-grafts. The integument covering the lid proper is very thin and is loosely joined to the underlying tarsal cartilage by extremely lax and delicate areolar tissue, which contains no fat. This thinness is quite essential to free and unrestricted movement of the lid, hence in substituting other skin for that of the lid, grafts of thin skin should be chosen from protected surfaces, such as the inner aspect of the arm where the skin is delicate and free from hairs and not from an extensor surface, where the integument is thick and the hair is coarse.

The looseness of the areolar tissue and the elasticity of the skin

covering the lids permit rapid and extensive extravasations of blood and inflammatory products and allow the emphysematous swelling sometimes seen after fracture of some of the thin bones of the inner side of the orbit, which also help to form the walls of the accessory sinuses of the nose. This same extreme mobility allows the skin to be easily drawn away by the contraction of neighboring cicatrices, and distortion of the lids is thus produced; because, at the free border of the tarsal cartilage the skin is firmly attached and the effect of the traction is felt most at this point.

The anterior border of the free edge of the lid is rounded and is the seat of the *cilia,* whose roots are deep and spring from the muscular and connective tissue. Hence the difficulty of their destruction by means of electrolysis. They are arranged in two or three rows and curve away from the eye-ball. This angle between the cilia and the globe must be restored in the final result of all successful operations for entropion and trichiasis. To accomplish this a pronounced over-effect is usually necessary at the time of operation.

The sebaceous follicles of the eye lashes are known as the glands of Zeiss.

The outer margin of the free border of the lid is rounded and soft while the inner border presents a sharp, angular edge and resembles cartilage in its firmness. In health this sharp edge lies smoothly upon the globe, whose surface it cleanses with every act of winking, but if, either by disease or operative interference, a deformity is produced, so that this sharp edge is turned in upon the cornea, it becomes a source of serious irritation and often leads to complications of the cornea; or the sharp angle, through chronic blepharitis, may become absorbed, in consequence of which the cilia are brought down in contact with the cornea, to rasp and roughen it. Ulceration and pannus are frequently engendered by this condition. At the inner extremity of this sharp-edged border, and about 6 mm. from the inner canthus of the eye, are located the *lachrymal papillæ,* two small elevations on whose crests are the *puncta lachrymalia,* the minute orifices of the *canaliculi.* As the drainage of the conjunctival sac depends upon their patency and proper apposition with the globe it would seem that a word of warning about injuring them or altering their position is superfluous were not such needless and baneful distortions so frequently observed.

The space between the cilia and the sharp inner margin of the free border is called the *intermarginal space,* and its covering is more in the nature of dermal than of mucous tissue. This space is of considerable surgical importance as it is the seat of incisions in many operations for entropion, ectropion and trichiasis.

Just behind the cilia are found the openings of the glands of Moll (modified sweat glands), and just in front of the sharp posterior lip are the openings of the Meibomian glands, which produce a sebaceous secretion that lubricates the lid edges, the conjunctiva and the cornea. This secretion, together with that of the caruncle, serves to counteract the macerating action of the tears upon the lid margins and to act as a dam to prevent their overflow upon the cheek. It effectually seals the conjunctival sac when the lids are closed, and protects the cornea from extremes of heat and cold by covering it every few seconds with a coating of a poorly-conducting material heated to body temperature. When these glands are once destroyed, or their secretion perverted to a more oily nature, the cornea and those portions of the conjunctiva exposed by the open palpebral fissure become xerotic and otherwise diseased.

The *palpebral fissure* is irregularly elliptical in shape and the direction of its long axis is somewhat upward and outward. Hence it might seem that in making an incision for a canthoplasty this upward line should be followed. As a matter of fact, however, an incision whose direction is slightly downward gives a much better cosmetic result in consequence of the normal inclination of the furrow at that point.

The shape and width of the palpebral fissure are principally responsible for the expression and apparent size of the eyes. The so-called large and beautiful eyes are really so not because of the actual size of the globe but because of the width of the palpebral orifices. This fact is noticeable in the results of canthoplasty, especially following the phimosis of old trachoma. It is also made use of by the "beauty specialist." The use of cocain widens the palpebral opening and the effect of the enlarged opening is further enhanced by the accompanying mydriasis, thus giving the eyes an unusually large and dark appearance.

The Palpebral Muscles.

Beneath the epithelial covering of the lid is a layer of loose areolar tissue, in and behind which are the palpebral muscles. The *levator palpebræ superioris* takes its origin from the under surface of the lesser wing of the sphenoid, above and in front of the optic foramen. It is inserted into the upper border and anterior surface of the tarsus and the skin of the middle of the upper lid. Between the tarsus and the skin lies the *orbicularis palpebrarum*. It is a horse-shoe-shaped muscle, attached to the nasal process of the superior maxilla, (in front of the lachrymal groove), the internal angular process of the frontal bone and to the border and anterior surface of the internal tarsal ligament. It is also attached to the overlying integument but glides free-

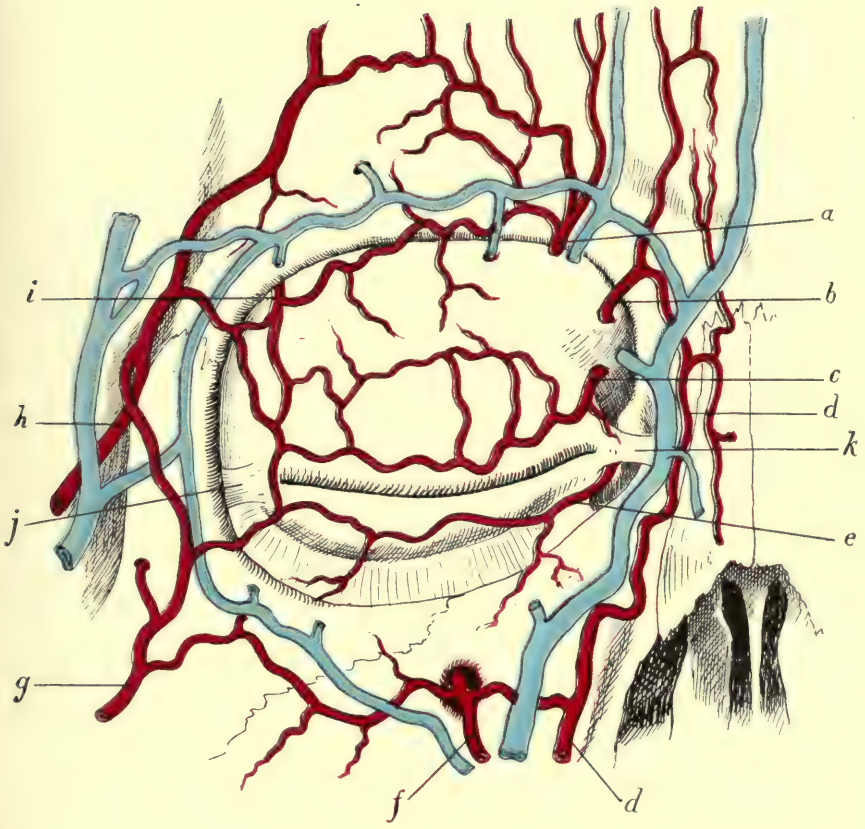


PLATE XII

The Veins and Arteries of the Eyelids. (After Testut.)

a. Supra-orbital artery.
b. Fronto-nasal artery.
c. Superior palpebral artery.
d. Facial artery.
e. Inferior palpebral artery.
f. Infra-orbital artery.
g. Transverse facial artery.
h. Superficial temporal artery.
i. Lachrymal artery.
j. External palpebral ligament.
k. Internal palpebral ligament.

ly over the tarsus. In canthotomy for spastic entropion it is necessary to divide the fibres of this muscle, or the external canthal ligament, well out to the mid-point to secure the temporary inhibition of its action which the operation is intended to produce. Likewise, in performing a canthoplasty, as a step in operations which have for their object the eversion of the tarsal cartilages, the external tarsal ligaments must be severed in order to give to the tarsus sufficient freedom to allow it to be turned out. Failure to divide these ligaments renders nil the results of many entropion operations.

Mueller's muscle, a layer of unstriped muscular tissue arising from the tarso-orbital fascia, is also inserted into the upper border of the tarsus.

The *tarsi* are two plates of dense connective tissue, which give the lids rigidity of form and furnish attachment for the muscles. They are about 25 mm. in length, and the two extremities are connected with the lateral walls of the orbit by the internal and external palpebral ligaments. The upper tarsus is about twice the width of the lower. Between the superior edge of the orbit and the convex border of the tarsus stretches a thin aponeurotic membrane which, with the foregoing structures, forms the *septum orbitale.* This membrane fuses with the tarsal ligament externally but internally it separates from the ligament to find attachment on the lachrymal bone immediately behind the lachrymal sac, while the internal tarsal ligament is inserted in front of it.

It will be seen that the tissues of the lid naturally divide themselves into two parts or leaves; the outer leaf containing the integument and muscular tissue, the inner leaf the tarsus, its attached aponeuroses and the conjunctiva. The two parts are loosely connected by areolar tissue. This arrangement facilitates many operations on the lids.

The Surgical Anatomy of the Conjunctiva.

The inner or palpebral surface of the lid is covered with the *conjunctiva,* a mucous membrane closely adherent to the tarsus and reflected over the anterior part of the sclerotic and the cornea, thus forming the conjunctival sac. Over each of these tissues it undergoes considerable modification. The palpebral portion is thick, opaque and closely adherent to the tarsus. It is richly supplied with blood vessels, its surface presents numerous papillæ, and its stroma contains an amount of lymphoid tissue. The reflection of the conjunctiva from the tarsi to the globe forms the fornix, or retro-tarsal folds. These folds are much convoluted, thus permitting great freedom of motion of the globe. On account of this laxness marked chemosis may occur in inflammations of the conjunctiva. The necessity of this looseness of the retro-tarsal fold to the unrestricted movement of the globe

should be borne in mind in operations for symblepheron and restoration of the cul-de-sac. At the inner angle of the eye this reduplication of conjunctiva is most pronounced, forming a well-marked semilunar fold, the *plica semilunaris.*

The bulbar conjunctiva is very loosely attached to the underlying sclerotic coat by the episcleral tissue, except at the sclero-corneal margin where it is closely adherent. The laxity and elasticity of the conjunctiva most admirably adapt it to plastic operations on this part of the globe. It is transparent, only slightly vascular and contains no glands. The part of the conjunctiva forming the outer layer of the cornea is so modified that it consists of only a thin layer of stratified epithelium.

The *arteries of the lids* are continuations of the ophthalmic and facial arteries at the inner side of the nose, and a branch of the temporal near the upper-outer angle. In making pedicled flaps the long axis of the flap should correspond with the direction of the larger blood vessels, where this is possible, in order to give them the best possible nourishment.

The *veins of the lids* for the most part empty into those of the forehead and into branches supplying the ophthalmic vein, in order to reach which they must pass through the fibres of the orbicularis. Consequently contraction of the orbicularis, be it from inflammatory infiltration or from blepharospasm, interferes with the return circulation and leads to edema of the lids and to an aggravation of any morbid process in these parts. This fact explains why these cases often resist treatment until a free canthotomy is performed, which paralyzes the sphincter action of the orbicularis and relieves the pressure upon the globe.

The *lymphatics* form two nets, before and behind the tarsal plates. They drain into the preauricular, parotid and submaxillary lymphatic glands.

CANTHOPLASTY.

Literally, this word signifies an operation for the correction of an anomalous condition of the external commissure of the lids, and is to be distinguished from *canthotomy* or *tarsodialysis*, which means merely a cutting of the canthus. According to its common acceptation, however, the term is used in both senses, yet with this difference; simple incision of the canthus, without the addition of sutures, is called *provisional canthoplasty;* while the more finished operation, wherein there is an external canthotomy and the divided conjunctiva and skin are stitched together, or yet further elaborated, is known as *definitive canthoplasty.*

The former term is applied, for example, to the *temporary* elongation of the palpebral fissure that is made preliminary to exenteration of the orbit, to the enucleation of a globe of extra size, to the extraction of cataract where the conjunctival sac is much shrunken, and to relieve pressure, as in phlegmon of the orbit, in the intense chemosis of gonorrheal ophthalmia, and in panophthalmitis.

The *second* refers to *permanent* extension of the outer commissure for the correction of blepharophimosis, for ankyloblepharon, and for relief of the damaging lid tension in chronic trachoma. It is also an important part of many operations for entropion, and is occasionally the sole measure adopted for the cure of spastic entropion.

It may be stated in passing that canthotomy, pure and simple, is seldom practised nowadays, as even in most of the instances just given it is followed by sutures.

C. R. Agnew, of New York, was the first, in 1875, to demonstrate the immense value of canthoplasty as a therapeutic measure in inflammations of the conjunctiva and cornea, such as the more severe phases of phlyctenular and interstitial keratitis and trachoma.

The von Ammon-Agnew Method of Canthoplasty.

Agnew's *cantholysis* is a modification of the operation devised by von Ammon in 1839. It is the simplest method and the one chiefly in vogue among American surgeons.

The *instruments* employed are large and small straight, blunt scissors, mouse-tooth forceps, needle-holder, and two or three fine curved needles. General anesthesia is resorted to only when absolutely necessary. Local anesthetics help slightly. The patient lies on the table.

First step. *The canthotomy.* The outer commissure is held moderately open by the left thumb and index finger; one blade of the large scissors is slid into the outer cul-de-sac as far as it will readily go, its edge exactly beneath the angle of the lids and in line with the closed palpebral fissure. The other blade is closed down until it touches the skin, a good grip is taken on the handles, so that the blades will not "buckle," and with one firm snip the cut is made. The skin incision should be from one to one and a half centimeters long, according to the demands of the case; the conjunctival cut should reach to the bottom of the cul-de-sac. Although the cut is usually made in a perfectly horizontal direction, in many individuals the scar conforms better to the natural topography of the outer canthus if it be given a somewhat downward inclination.

One should bear in mind that a part of the accessory lachrymal gland lies in this region and strive not to injure it wantonly.

There will be some bleeding, but it usually ceases spontaneously.

Second step. *Division of the external canthal ligament.* The free border of the upper lid is grasped by the left thumb and index, pushed slightly up to open the spaces between the severed skin and conjunctiva, and the small scissors, closed, are put into the upper opening to feel for the ligament. The lid is now pulled forward toward the nose, so as to make the ligament taut, when the scissors are opened slightly, the blades are pushed up astride the ligament about midway of its length, and it also is cut with a single snip, and at right angles to the primary incision. Some authors state that the conjunctiva is unavoidably incised in dividing the ligament; such is not the case, for with delicate scissors and a little care, neither the skin nor the conjunctiva need be wounded. If the snip is successful the lid at once gives way under thumb and finger. If it fails to yield, another and more careful effort must be made. The same procedure is repeated on the lower section of the ligament.

Third step. *Placing and tying the sutures.* An assistant opens

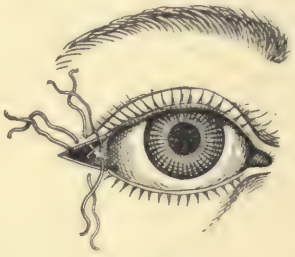


Fig. 701.

Agnew's Cantholysis, or Modification of the von Ammon Canthoplasty.

wide the extended commissure. It will be observed that the cut in the skin is longer—often very much longer—than that in the conjunctiva. Now, all the descriptions of the operation that I have ever read, and all the many cuts that I have seen illustrative of it, teach that the angle of the conjunctival opening should be joined to that of the skin. This is precisely what Agnew insisted should *not* be done, and with substantial reasons; for, because of the inequality in the length of angles alluded to, thus to unite them means the obliteration of the external cul-de-sac; not only this, but it also means undue stretching of the conjunctiva to force it to meet the skin at this point, hence, the formation of an unseemly bridle or band that is particularly noticeable and restricting when the globe is in adduction. Instead, therefore, following Agnew, after picking up the conjunctival angle with the needle, it is carried outward as far as it will go without any stretching and is joined to the upper lip of the incision. See the figure.

Another suture is placed to unite the lower skin and mucous lips, and sometimes a third to perform the same office above, and the operation is finished—unless, perchance, one chooses to put in a fourth or superficial suture to close the small skin angle thus left unclosed. Care must be exercised not to include the canthal ligament in suturing. As each suture is put in, if it be not tied at once, the two ends of thread are laid together on the temple where an assistant places a finger on them to insure keeping each pair to itself. They are tied with the canthus stretched open, in order to see that they are true, and not tied too tight lest they cut out of the conjunctiva.

Other Methods of Canthoplasty.

Several ingenious and effective varieties of canthoplasty have also been devised and extensively practised. Attention is called to three:

1. Richet resected a dart of skin and tarso-orbital fascia whose base is the canthus and whose point reaches outward horizontally one and one-half centimeters. A median horizontal incision is made in the outer wall of the external conjunctival cul-de-sac thus laid bare, and the cut edges are stitched to those of the skin.

2. David Prince, of Jacksonville, Ill., made a cutaneous incision, beginning on a level with, and three or four centimeters from the commissure, down and in, parallel with the lower lid border, one-third to one-half of the length of the latter; then from this point out and up back to the level of the canthus, but several millimeters further toward the temple. The curved angle of skin thus marked out was dissected up from apex to base. A third incision joined this base and the canthus, the upper lip of which was undermined for a centimeter or more toward the brow. A double-armed suture was put through the point of the curved flap outlined by the first two incisions; it was then tucked up into the pocket made by the undermining of the upper lip of the horizontal incision, the suture was brought out through the skin beneath the supercilia, and it was tied over cylinders of buckskin or other material. The remaining angular opening was closed by sutures, which completed a clever method for combining canthoplasty with correction of moderate ectropion of the lower lid.

3. V. Chalot makes an incision through the skin only, extending from the canthus outward one and one-half centimeters. This he crosses with a vertical skin incision, made flush with the canthus, the two forming a capital ⊣, supine, against the canthus. The two angles he dissects or undermines, exposing a bridge of conjunctiva. This is incised above and below, turned outward, and sutured to the angle of the cutaneous incision.

TARSORRHAPHY.

Tarsorrhaphy or blepharorraphy is a procedure which aims to produce adhesion of the lid edges and a consequent closure of the palpebral fissure. It may be complete or partial, internal, median or external, depending upon the extent and part of the lids operated on. It may be permanent or temporary. Its use is indicated for the protection of the exposed cornea, as in paralysis of the seventh nerve, neuroparalytic keratitis, and pronounced exophthalmos; for the correction of some forms of ectropion; for eversion of the puncta and of paraphymosis; also to partially immobilize and hold the lids in position in certain surgical operations for the restoration of the lids and conjunctiva, and to prevent cicatricial ectropion after extensive destruction of the palpebral skin.

Walther's Operation of Tarsorrhaphy.

This form of the external method was first practised by Walther and antedates the median method by several years. Before the introduction of median tarsorrhaphy it was very extensively used, and is still often resorted to where a permanent union is desired but should not be used as a provisional step if one wishes, later, to free the lid edges which it is the object of this operation to unite.

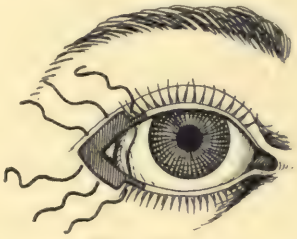


Fig. 702.
Walther's External Tarsorrhaphy.

This adhesion is accomplished by excising strips of skin from the margins of both upper and lower lids, of sufficient depth to include the follicles of the cilia and extending as far out from the canthus as the degree of closure desired seems to demand. (See the illustration.) The raw edges are united by sutures which pierce the entire thickness of the skin, tarsus and conjunctiva and hold its parts in correct apposition. They should usually be removed at the end of from four to six days.

Fuchs' Tarsorrhaphy Operation.

A modification of Walther's, it produces a more firm union than the original. Like the other operation it, too, destroys the cilia, hence should be used only where a permanent result is desired. It is per-

formed as follows: An intermarginal incision 5 mm. deep is made in the lower lid corresponding in area to the part to be closed. This incision divides the lid into two leaves, one composed of skin and subcutaneous tissue, the other of tarsal cartilage and conjunctiva. At the nasal end of the incision a vertical slit is made in the outer leaf, allowing the leaves to gape. Like incisions are made in the upper lid with the addition of a second horizontal incision in the skin half, which entirely removes this part, leaving a denuded area about 5 mm. wide

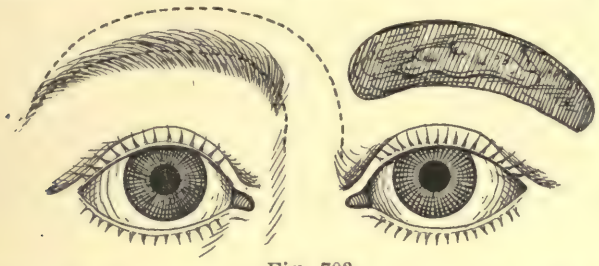


Fig. 703.

Goyanes' Operation for Restoration of an Eyebrow. First Stage.

and the length of the incision. Over this denuded space is drawn the skin flap of the lower lid by means of double-armed sutures which are tied over a roll of gauze, or suitably protected in some other way. One or two fine skin sutures may be necessary to complete the work.

Internal Tarsorrhaphy.

Occlusion of the inner commissure, under the name *canthorraphy,* was first resorted to for the exophthalmos that followed the too free

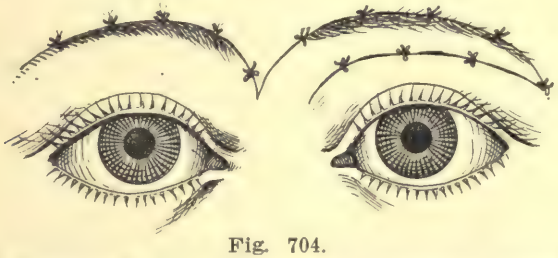


Fig. 704.

Goyanes' Operation for Restoration of an Eyebrow. Second and Final Stages.

tenotomies practised in the early operations for strabismus. The operation was given definite technic and systematized by von Arlt, who called it *median tarsorrhaphy,* to distingush it from the *external* or *lateral* variety. Its principal indications, perhaps, are in slight degrees of atonic ectropion with eversion of the lachrymal punctum, and in the sagging of the lower lid from the wearing of an artificial eye. By some, however, it is considered preferable to the median form for

lagophthalmos. Its results are certainly less disfiguring than are those of external tarsorrhaphy.

Arlt's Operation for Internal Tarsorrhaphy.

The operation is performed as follows: A narrow strip of skin is resected from around the inner canthus, being very care-

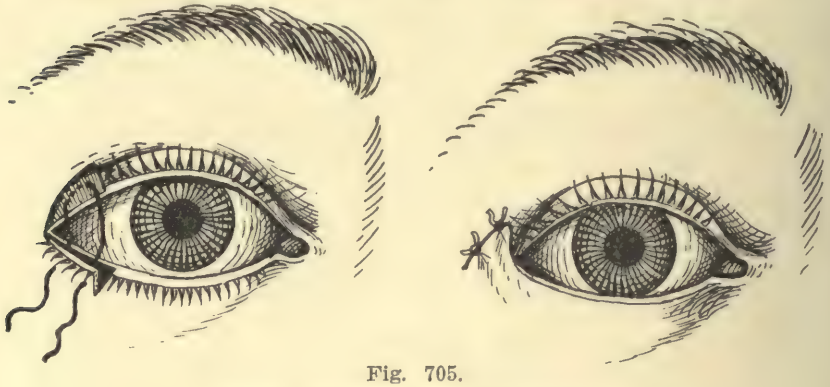


Fig. 705.
Fuchs' Operation for Tarsorrhaphy.

ful not to wound the underlying canaliculi, and the two raw edges brought together by means of fine sutures, as shown in the illustration. The incisions should not, of course, be so extensive as to encroach on the puncta. At the end of a few days union will be complete and the stitches may be removed.

The Bowman-Panas Operation of Median Tarsorrhaphy.

Median tarsorrhaphy was first introduced by Bowman and later

Fig. 706.
Graefe's Operation for Tarsorrhaphy.

modified by Panas, who performed it in the following manner: The eyelids are closed and the point selected for occlusion marked on both upper and lower lids. If the eye has useful vision this part should not

be more than half a centimeter in length and should be situated a little to the inner side of the center so that the outer opening may be used for distant and the inner one for near vision. The location of the bridge having been properly marked the lower lid is held firmly against a horn spatula, or grasped by a fixation forceps, and a thin slice of the tarsal portion of the free border removed without injuring the cilia or their follicles. The upper lid is treated in the same way. Two sutures are next passed through the entire thickness of each lid, the denuded areas drawn into accurate coaptation, and the sutures tied over a section of small rubber tubing, roll of gauze or a cylinder of cotton. They may also be tied in bow knots and the slack in the thread taken up if the sutures become loose. In either case the sutures should be reinforced by means of adhesive strips. After four or five days union will be sufficiently firm to permit removal of the sutures. If it is found desirable the entire bridge, or any part of it, may be subsequently freed without causing any deformity, since the cilia have

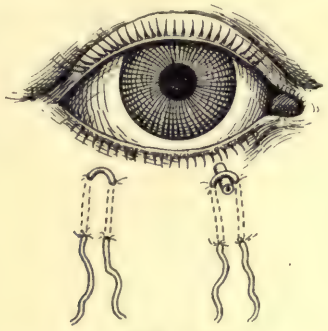


Fig. 707.
Position of the Sutures, Before Tying, in the Arlt Operation.

not been destroyed. The immediate result of the operation is to close the lids completely. After a variable length of time, however, the free portions of the lid become so curved that they form two ellipses of sufficient width to allow fair vision but not sufficiently wide to cause trouble from exposure of the cornea.

The Graefe operation is also pictured in the text.

This procedure has proven most satisfactory at the hands of the writer in those cases where the cornea is in danger from over-exposure. Not the least of its advantages is the fact that when the occlusion thus produced is no longer needful it may be relieved in a moment, by a simple incision, and not a trace be left behind.

Bossalino's Tarsorrhaphy.

This operation produces permanent union of the lids, conserves the ciliary margin and is both simple and effective. Both lids are split

the distance of the proposed union and divided into two leaves, the outer consisting of orbicularis and skin, the inner of tarsus and conjunctiva. One end of a double-armed suture is then passed from the conjunctival surface forward through the posterior leaf of the lower lid and into the apex of the cleft in the upper lid, passing diagonally up through the orbicularis and skin, emerging at a point about 14 mm. above the lid margin. The other end of the suture is similarly inserted parallel to this, but a few millimeters away. When the ends are drawn tight the posterior lip of the lower lid is pulled up into the cleft in the upper lid giving an extensive surface for union. The ends of the suture should be tied over a piece of rubber tube or roll of gauze.

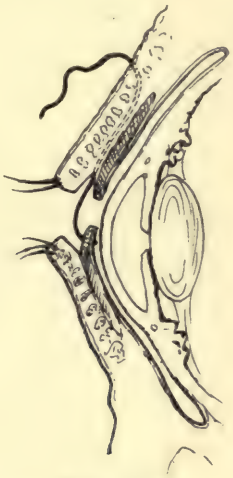


Fig. 708.
Bossalino's Tarsorrhaphy.

Total Tarsorrhaphy.

This, literally speaking, is, of course, never made, as an outlet must be left for the lachrymal and other secretions. Lisfranc was the first, in 1836, to make the so-called total occlusion. He did it to stop the progress of anterior staphyloma of the globe.

It is the best preventive of cicatricial ectropion after extensive destruction of the palpebral and adjacent skin from burns, blastomycosis, etc., and is useful to enhance the effects of operations for such ectropion. The simplest and best method is merely an extension of that of Panas for median tarsorrhaphy. A small opening should be left both internally and externally for the double purpose of allowing drainage and to facilitate reopening of the palpebral fissure at the proper time.

CLASSIFICATION OF METHODS IN SKIN GRAFTING.

General Considerations.

Plastic surgery of the lids finds its chief indication in the relief of those malformations due to the contraction of cicatrices, either of the lids themselves or of neighboring parts. It is also resorted to for correcting deformities due to deficient or excessive development of congenital origin, to the loss of parts from injury, burns or operations for malignant growths, or to the destructive ulceration of syphilis, tuberculosis, lupus and other diseases. Hyperplasias from chronic inflammation frequently call for surgical intervention, as does also loss of function of the lids due to lesions of the seventh and third nerves.

Operative intervention is *contraindicated* if the patient have a syphilitic infection that has not had proper treatment, if he be in an advanced stage of diabetes or Bright's disease, give a history of hemophilia or be in a state of marked debility. Local contraindications are lupus that has shown signs of active ulceration in the past six months, any acute infection of the conjunctiva or lids, or chronic dacryocystitis.

The exact results of plastic operations can never be accurately foretold, a fact which should deter one from resorting to them except in cases where it is evident that even a moderately successful result would cause less inconvenience and disfiguration than the original lesion. A guarded prognosis should be given the patient if the operation is to be an extensive one, for while many plastic operations are functionaliy satisfactory, the majority are cosmetically disappointing to the patient. Care in minor details, especially accurate approximation of skin edges, will do much to minimize extensive scarring.

These operations naturally divide themselves into four groups:

I. *The Replacement or Readjustment of Tissues.* This may be done by the excision of parts and coaptation of the edges, with or without undermining the adjacent skin. This is commonly known as the French method and usually produces a minimum amount of disfiguration.

II. *Transplantation with a Pedicled Flap.* (a) From adjacent parts (as in the Indian method), (b) from distant parts (as the arm in the Italian operation for restoration of the lid), (c) from another individual.

The first method is the one in common use, the second is rarely used, and the third, while theoretically possible, is practically never resorted to. These pedicled flaps may be slid, twisted, rotated, everted, stretched or freely manipulated in almost any way to get them into position. They may, if necessary, be bridged over healthy tissue or

moved from comparatively distant parts by repeated transplanting of alternate ends.

The pedicled flap usually survives, hence this operation is satisfactory as far as function is concerned, but sometimes results in disfiguring scars.

III. *Cutaneous Grafting or Transplanting without a Pedicle* is usually done by one of three methods, (a) Reverdin's method, by means of isolated islands of skin; (b) Thiersch grafts, thin sheets comprising the epidermis and the upper part of the corium; (c) the Wolfe graft, in which the entire thickness of the skin is used.

The grafts for any of these three methods may be taken from other parts of the patient's body, from another living individual, from a cadaver or amputated limb not more than 12 hours dead, or from one of the lower animals, as a live rabbit, chicken or frog.

The Reverdin graft is seldom used in lid surgery. The Thiersch grafts frequently give a large measure of relief but seldom look like normal skin. The difference is not so apparent at about body temperature but becomes evident in extremes of heat or cold.

IV. *Benign Cicatrization* tends to correct deformities by the contraction of properly placed cicatrices. These scars may be produced by means of sutures, linear cauterization or cautery puncture. The method is useful where the degree of deformity is slight. It causes little disfiguration and may be repeated as often as necessary in order to produce the desired result.

Choice of Plastic Operations.

In doubtful cases it is well to err on the side of conservatism. The results of plastic surgery, especially of skin-grafting, are so uncertain and the resultant contractions are so long continued that the ultimate accomplishment of radical interference is frequently as bad as, or worse than the defect it was intended to correct.

The *replacement or readjustment of tissues* by fashioning and mobilizing flaps of adjoining skin should be chosen whenever possible, unless it is obviously unsuited, or will produce too great tension. So far as the life of the tissue is concerned these operations are practically all successful, and usually leave a small amount of scarring if properly performed. By extensive undermining of the adjacent skin, and taking the proper precautions to prevent too great tension by means of tension sutures and adhesive strips, this form of operation has a wide field of usefulness, especially in restoration of the lower lid, and should be more frequently employed than it is.

In *transplantation with a pedicle* the flap practically always survives if the pedicle be not too narrow, but it is frequently attended by considerable disfiguration. It finds its greatest usefulness in restora-

tion of the lids or the canthi where there has been extensive loss of tissue. It is also useful where the seat of operation furnishes poor nourishment to a skin-graft, as close to or upon bone. The operation should not be too complicated or involve more incisions than are absolutely necessary. The great elasticity of the skin makes numerous incisions unnecessary, especially if the integument has been extensively undermined.

Transplantation without a Pedicle. The Reverdin, Thiersch and Wolfe methods possess certain advantages and drawbacks, the preponderance of which must determine their adaptability for individual cases. They are employed only when the extent of the injury or its location renders either of the preceding methods impracticable.

The *Reverdin graft* is seldom used except in cases of indolent ulceration, which is proving destructive to the lids. These grafts are poorly nourished and are followed by pronounced contractions. Even after the surface becomes covered with new epithelium it not infrequently breaks down and the ulceration becomes active again. There rarely is any indication for their use about the lids.

Thiersch grafts are suitable for small areas in any location, or in more extensive ones where body is not essential. Their nutrition is always poor and they seldom look like healthy structure. They are frequently used in operations upon the conjunctiva, on account of their thinness, but in this location they are constantly subjected to the macerating action of the tears and must be frequently wiped off in order to keep them free from dead epithelium. Mucous grafts, as from the human lip, or the conjunctiva of one of the lower animals, for example that of the rabbit, are not open to this objection. One advantage of Thiersch grafts is that if a part perishes the defect can, without affecting the ultimate result, be easily remedied by a subsequent operation. About 75 per cent. of these grafts survive.

In comparatively large areas, *Wolfe grafts*, composed of the entire thickness of the skin, give the best cosmetic and functional results. They have a better color and are not so subject to prolonged contraction as the thin grafts; while their use is free from the disfiguration due to extensive scars or secondary grafting following the use of large pedicled flaps. They are especially useful where secondary contraction would produce disaster.

Preparation for Plastic Operations on the Lids.

Since the same general procedures are followed in the various kinds and modifications of these operations they will be given in full here and not repeated with each operation.

If the operation is to be at all extensive the patient should be given a general anesthetic lest the contortions of the face from pain, and

the surgeon's reluctance to cause suffering, prevent that thoroughness of intervention, that nicety of arrangement and accurate coaptation upon which the success of the operation so much depends.

The field of operation should be cleansed in the usual manner and all strong antiseptics thoroughly washed away with sterile normal salt solution. Asepsis is here much preferable to antisepsis.

If the *seat of operation* is an old cicatrix every vestige of cicatricial tissue should be cut away, the edges of the wound made even and its base comparatively smooth. If it is a granulating surface, the superficial granulations should be curetted away and the edges of the wound freshened. In either event all hemorrhage must be stopped by pressure or hot applications, since a clot beneath a graft will prevent primary union.

If a graft is to be used the healthy skin from which it is taken should have been previously scrubbed lightly with water and green soap, washed off with boric acid solution or by normal salt solution and afterward carefully protected by means of a secure sterile dressing.

For operations in which the skin is simply readjusted no general directions are necessary except a warning against attempting an operation which would put too much tension on the sutures, or produce tension in such a way as to cause deformity in the ultimate result.

In using pedicled flaps they should be fashioned, where possible, by means of curved lines and with broad based attachments and rounding ends; long, tapering or pointed ends are apt to perish. The various operations under these classes will be described in detail.

Reverdin's Method of Skin Grafting.

Epidermic grafts. After proper preparation of the wound and the site from which the graft is to be taken, the small pieces of skin for the graft are picked up with small forceps, a short hook or a sewing needle, and the graft cut off with small scissors or a scalpel. The piece removed should not be more than 5 mm. square and should include the epidermis and the superficial part of the dermis. These small grafts are placed immediately upon the wound, where they are arranged about 10 mm. apart.

The grafts are covered with thin sheets of cotton moistened with boric acid solution, strips of gutta percha, a sheet of perforated gutta percha or very coarse meshed gauze such as unstarched mosquito netting. Upon this is placed a hot gauze compress wet with sterile physiological salt solution, and over this a sheet of oiled silk, rubber tissue, paraffin paper or some other material impervious to air, in order to retain the moisture. This in turn is covered with a generous layer of absorbent cotton, and over all a bandage of such material and firmness as to prevent any possibility of displacement. Starch bandages, mos-

quito netting or roller bandages freely painted with collodion serve the purpose most admirably. At the end of forty-eight hours the dressing is changed down to the last layer of rubber tissue, which is not disturbed. The wound is irrigated with warm normal salt solution and redressed as originally. This dressing should be repeated each day thereafter for a week, at the end of which time the rubber tissue may be carefully removed, the wound well covered with vaseline, and a lighter dressing applied. This protection should be continued until the intervals between the islands of skin are well covered with epithelium.

Reverdin's method was modified by Ollier, who made the grafts larger, from ten to fifteen mm. long by one to three mm. wide. He also made them thicker so as to include a part of the corium. In order to do this, the entire thickness of the skin was removed, as in the Wolfe graft, and then pared down to the proper dimensions with a razor. The graft thus prepared was implanted upon granulation tissue of about three weeks' standing. In cases where healing had occurred the cicatrix was carefully removed and the surface allowed to granulate before the graft was applied. Lawson was the first to use this graft in blepharoplasty.

Thiersch followed in the steps of Ollier save that he did not implant the graft upon a granulating surface. He held that granulations form a layer of scar tissue and, therefore, make an unfavorable base for the transplanted integument. He advised the removal of all granulations by curettment and thus to make the wound a *fresh* one. He cut the grafts thinner than Ollier, but not so thin as did Eversbusch, who inaugurated the translucent grafts in use today—the true epidermic graft, known in America as the Thiersch graft, and in Europe as the Thiersch-Eversbusch graft.

The Thiersch Graft in Blepharoplasty.

The preliminary preparations as outlined above are followed in this operation. The graft is usually chosen from the inner aspect of the upper arm or the thigh and removed in as few pieces as is adequate to cover the bared space. It is very difficult to obtain pieces larger than 3 by 8 cm. For obtaining the graft a special knife with a perfectly flat blade—the Thiersch knife—has been designed, but an ordinary razor that can be sterilized will answer the purpose very well. Both the knife and the skin should be perfectly dry and the skin put upon the stretch by an assistant. This can best be done by having some straight-edged instrument dragged along just in front of the razor. The blade is held perfectly firm and flat, and the graft removed by a wide, sawing motion. If properly cut the blade can be constantly seen through the graft, and the raw surface from which it is removed will be thickly studded with minute bleeding points which mark the lo-

cation of the severed papillæ. That is, the graft should be of a thickness sufficient to include the epidermis and the upper part of the papillæ. Without removing it from the razor blade the graft is transported to the wound, which has been dried as thoroughly as possible. The graft is deposited upon this comparatively dry surface with as little manipulation as possible. There will be sufficient exudation to cement it firmly to its new bed. The common practice of flooding it with salt solution only tends to its displacement. The grafts should slightly overlap each other and the edges of the healthy skin, as there will be considerable shrinking.

It may be added that the cutting of a large and perfect graft is greatly facilitated if the lower side of the blade be smeared with vaseline.

Two methods are used in dressing the wound. Some surgeons apply no dressing at all for several hours and allow the drying serum to glue down the strips of skin. Usually, however, they are immediately dressed, precisely as the Reverdin grafts, and given the same after-treatment. There is considerable immediate and subsequent shrinkage. For this reason the aim in cutting the graft should be to make it about one-third larger than the wound it is intended to cover.

The Wolfe Graft in Plastic Surgery of the Eyelids.

In the preparation of the Wolfe graft the constant thought should be provision for the enormous amount of shrinking which these grafts undergo, and the consequent primary over-effect which must be secured.

The preliminary operations having been made, as in the previously described operations, a pattern of sterile paper or rubber tissue should be cut to conform to the shape of the open defect. This pattern is then placed on the skin from which the graft is to be taken and an outline made with the point of a knife conforming to its shape, but far enough from its borders *to make the uncut graft about four times the size of the wound-defect* to be covered. It is a good plan to partially dissect up the ends of the graft first and put a fine suture through each from the epithelial side. The stitches are most easily inserted at this time, thus effecting a saving of manipulation of the graft and minimizing its exposure to the air. It also facilitates orientation when the graft is placed on its new bed, as these stitches are easily inserted into the ends of the wound and the graft made secure. Following this outline a deeper incision is made through the entire thickness of the skin, and the graft removed with as little traumatism as possible.

All subcutaneous fat is rapidly snipped off with scissors, the graft being occasionally moistened with warm, sterile, normal salt solution, to prevent its becoming dry. It is then adjusted to its new bed, the

edges accurately approximated and sutured where necessary. Many stitches are not only unnecessary but a positive injury. The seat of the graft should in some way be immobilized, and the wound dressed as in other forms of skin-grafting.

The first dressing need not be disturbed for 2 or 3 days, at which time at least some of the stitches may be removed, especially if they show signs of suppurating. The moist dressings should be continued for about 7 days, when the surface of the skin is covered with sterile vaseline and a light dressing applied. During this time the graft may present a widely varying appearance, ranging from a continuous healthy pink tint to the greenish black of dry gangrene. The color of the graft during this time furnishes little ground on which to base a prognosis as to the final result. Some of the best results follow those cases where the superficial layer of the graft turns black and sloughs off, while in other cases grafts which look healthy for several days may perish entirely. As a rule, however, the graft first appears blanched, but at the end of twenty-four hours, if all is well, something like its normal tint is present. On the second day it has a rosy hue. On the third day it appears whiter, due to the shedding of the epithelium. After this process is completed it becomes again slightly redder than the surrounding skin, but ultimately fades out until it is somewhat paler than the adjacent parts. It cannot be considered entirely safe until about the 9th day, for the entire graft or any part of it may perish from gangrene, secondary hemorrhage, stitch-canal or superficial infection, phlegmon or erysipelas. If these complications appear they will become manifest in the first few days. For sloughing, hemorrhage or gangrene little can be done. Infections are to be treated by removing the sutures, if they are causing the trouble, and copious warm irrigations of mild antiseptics, such as boric acid or potassium permanganate, 1-6000. Many days after the graft has become viable progressive ulceration may appear and destroy it in a short time unless vigorously combated. An effective treatment is to paint the affected surface with 12 per cent. silver nitrate, followed by warm normal saline solution.

OPERATIONS FOR SPASTIC AND MECHANICAL ECTROPION.

Spastic ectropion, also known as *muscular* or *acute ectropion*, usually affects only the lower lid. This is perhaps due to the comparative narrowness of the cartilage and to the absence of such a correcting influence to eversion as the overhanging supraorbital ridge furnishes to the upper lid.

This form of ectropion is caused by the contraction of the orbicularis, opposed by a globe surface farther forward than its normal po-

sition. The lower lid is thus pulled up and back by the action of the muscle, which has the effect of pushing the free edge down and out by the resistance offered by the protruding eye-ball. As a result the action of the marginal fibres is overcome and eversion results. Once established the condition is perpetuated by the action of these same fibres, and by the swelling of the palpebral conjunctiva which results from exposure to the air and from congestion due to interference with the circulation. When both lids are affected and the condition becomes extreme it is called *blepharo-paraphymosis.*

The *commoner causes* are chemosis of the conjunctiva, and protrusion of the globe from orbital cellulitis.

For the *correction of spastic ectropion* the most essential thing is to remove the cause, if possible, and to restore to position and mechanically support the lids until the acute trouble has subsided. If the exciting agent be a pronounced chemosis the conjunctiva may be freely incised to promote its reduction. If it be a conjunctivitis it should be treated according to the indications. Whatever the cause proper measures should be taken to correct it and the lids restored to position and held there by strips of adhesive plaster, by bandaging or other means. If the cramp in the muscle has produced an eversion which will not remain reduced, a canthotomy, combined with free severing of the external canthal ligament, is indicated.

Mechanical ectropion is produced by the same forces as the spastic form, with the difference that here the exciting causes are chronic while in the other they are acute. It is produced by the action of the orbicularis opposed by an advanced anterior surface of the globe, due most frequently to exophthalmos, staphyloma, tumors and hypertrophy of the conjunctiva. When due to the last condition it is also called *mucous ectropion.*

Author's Case Showing the Use of the Wolfe Graft in Blepharoplasty.

As has been previously stated, the shrinkage which the Wolfe graft undergoes is very great, and the surgeon who does not take into account this important element in plastic surgery of the lids will uniformly fail to produce the desired effect in most cases of blepharoplasty. Figure 709 and Figure 710 show in graphic fashion the degree of contraction which a Wolfe graft generally undergoes when it is used for the purpose indicated. The photographs also illustrate other phases of the operation, which was undertaken for the restoration of the right lower lid.

The patient had suffered extensive destruction of the palpebral skin from deep ulceration. The ulcerated area, on healing, had been followed by an exaggerated ectropion. For the cure of this condition an operation was undertaken which consisted in

making an incision parallel with and about three millimeters from the free border of the lid. This incision was extended beyond the canthi and in both directions, the dissection being directed well beneath the surface, so as loosen freely the everted lid to such an extent that it could be readily turned up over the upper lid. When in this condition the cilia of the lower lid were in direct contact with the eyebrow. Of course, this left a large, elliptical defect in the lower lid skin, to cover which a Wolfe graft, measuring 7 by 10

Fig. 709.
Author's Case of Total Ectropion.

centimeters, was carefully excised from the inner aspect of the arm. The defect in the skin of the extremity was very extensive, so much so that in spite of free undermining of the surrounding skin and the employment of "bracket" incisions, the wound could only be partially closed; and the bare space was eventually covered with Thiersch grafts.

The edges of the Wolfe graft were lightly stitched to the borders of the facial and lid skin. The upper threads, well shown in the accompanying illustration (Figure 709) were left quite long

and were fastened to the eyebrow by collodionized gauze. The photograph, from which the cut is taken, was obtained at the time of the first dressing, about 48 hours after the completion of the operation.

The companion illustration (See Figure 710) furnishes a faithful picture of the result one month later. The proportions existing between the Wolfe graft, even after its removal from the arm (when considerable shrinkage had already taken place) to that

Fig. 710.

Author's Case of Complete Restoration of the Entire Lower Lid One Month after Operation.

which it eventually shrank, is a fair example of what may be expected in most of these operations. Nevertheless, if such cases are treated according to the rules laid down and great care be observed, not only in the preliminary preparation but in carrying out the important indications of sterility, sharpness of instruments, degree of graft shrinking, technique, etc., there is no reason why they may not be satisfactorily operated on.

For the *correction of mechanical ectropion* the exciting cause should be removed where it is possible for this to be done. Ablation of an anterior staphyloma or removal of a tumor may sometimes bring about relief. If there is a thickening of the conjunctiva due to chronic inflammation this should receive appropriate treatment.

Combined with the treatment of the cause of the ectropion it is usually necessary to aid in overcoming the condition by restoring the lids to position and holding them there by means of adhesive strips, collodionized strips, bandages or the author's laced dressing. The last named consists of a strip of tarlatan ribbon, near one edge of which is attached a row of tiny hooks similar to those used in fastening ladies' dresses. One strip of this is fastened by flexible collodion to the lower lid and another to the brow. The two are now laced together with a small cord and the lids drawn as tightly together as desired. For holding up the lid for a more extended period, as in exophthalmos, median tarsorrhaphy gives the most satisfactory results.

Fig. 711.

Snellen's Operation for Ectropion, Showing the Position of the Suture.

Snellen Suture in Ectropion.

In cases where the thickening of the lid is not due to swelling but has become an actual hypertrophy the redundant tissue must in some way be disposed of before the lid edge can be restored to its natural position. In those cases where the hypertrophy is of moderate degree the device most commonly employed, perhaps, is the *Snellen suture* (see figure) which seeks to draw this excess of conjunctiva down into the cul-de-sac where it will do the least harm, and at the same time exert traction in such a way that it tends to invert the lid. This well known operation is performed as follows:—Double-armed sutures are prepared from No. 2 braided silk thread boiled in paraffin. The needles are inserted about 2 mm. apart and a short distance inside of the line of eversion of the lid. They are passed diagonally through the lid so as to emerge from the skin about opposite the rim of the orbit. The sutures are now drawn tight—until the deformity is slight-

ly over-corrected—and tied over rubber tubing or other protective. Two or at most three such pairs of sutures, equidistantly placed, will be sufficient. They may be allowed to remain in position for several weeks or until they suppurate out, the eye being bandaged and dressed daily in the meantime. As suppuration progresses the sutures will become loose and may be tightened from time to time, the ends having been left long for the purpose. It is claimed that these lines of suppuration leave cicatrices which tend to hold the lid in place. Some surgeons use silver wire instead of silk thread on the assumption that it is better tolerated.

Ziegler's Operation for Slight Ectropion.

Ziegler attempts to reduce the deformity in mild cases by producing benign cicatrization in another way. Instead of depending upon sutures and suppuration to produce a scar he uses *galvano-puncture*. The punctures are made from the conjunctival surface

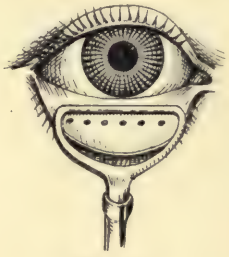


Fig. 712.
Ziegler's Galvano-puncture for Ectropion.

about 4 mm. from the lid margin and about 4 mm. apart. The cautery point is heated to a white heat and plunged into the conjunctiva and through the tarsus. There is a mild reaction and the operation may have to be repeated before the effect is sufficiently pronounced. The author of this method claims that its results are immediate and permanent and that it leaves no scar. It is a comparatively new procedure and has not been extensively practised.

Argyll-Robertson Operation for Ectropion.

It is perhaps an unusual thing for an out-curving of the tarsal cartilage to be the cause of ectropion or even to be a contributing agent of sufficient importance to demand attention. For the correction of those few cases where such a deformity does seem to be a pronounced feature Argyll-Robertson has performed the following operation, which is a modification of the Snellen sutures. A double-armed ligature of No. 2 braided silk, previously prepared by boiling in paraffin, is passed from the front straight through the entire thickness of the lid, 2 mm.

below the ciliary margin and about 6 mm. from the middle. It is carried free over the conjunctiva and reinserted at the bottom of the cul-de-sac, passing diagonally down and out so as to emerge 32 mm. below the lid margin. The other end of the suture is similarly placed 6 mm. to the other side of the midline. This arrangement leaves two vertical loops of thread crossing the palpebral conjunctiva about a centimeter apart. Beneath these loops is now inserted a lead plate (25x6x1 mm.) whose edges have been carefully smoothed and rounded off and which is bent to fit the curve of the globe. A roll of gauze is placed beneath the horizontal loop on the outside of the lid and the sutures are secured over its lower end. The sutures are allowed to remain in position seven days. If the lead plate is covered with paraffin it is less apt to cause irritation.

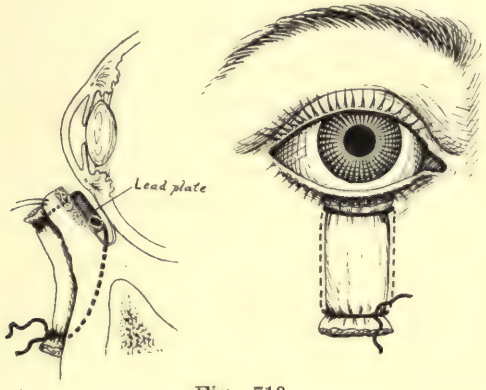


Fig. 713.
Argyll-Robertson's Operation for Mechanical Ectropion.

Fox's Operation for Ectropion.

Fox and others have developed an operation adapted to mild cases of mechanical ectropion where a hypertrophy of the mucous surfaces of the lid which fails to yield to treatment is the active agent in producing the deformity. This redundant tissue is removed in the following manner:

An incision extending the entire length of the lower lid is made 2 mm. from and parallel with its margin. The conjunctiva along the posterior edge of this incision is dissected back and a V-shaped piece of hypertrophied tissue removed. (See the figure.) Double-armed sutures of No. 2 braided silk thread, boiled in paraffin, are now passed through both lips of this wound 2 mm. below the ciliary margin of the lid and at the junction of the middle and outer thirds. After piercing the lid it passes free over the palpebral conjunctiva to be reinserted in the fornix and pass down and out, emerging from the skin

about 1½ inches below the free margin of the lid. The other needle is similarly inserted 3 mm. from and parallel to the first one. When this suture is tightened the V-shaped wound in the border is closed and the lid restored to its natural position. Pieces of rubber tubing protect the loops of the suture at either end. A like suture is placed at the junction of the middle and inner thirds of the lid. Two are usually sufficient. The conjunctival wound is not sutured but the edges are trimmed, if necessary, to produce good coaptation. The sutures are allowed to remain in only sufficiently long for the edges of the wound to heal—usually about three days—as it is not intended to produce suppuration here, as in the Snellen suture.

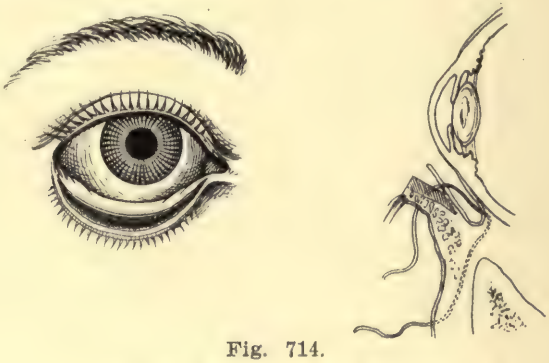


Fig. 714.
The Fox Operation for Ectropion.

OPERATIONS FOR ATONIC ECTROPION.

In *atonic ectropion* there is manifestly too great laxity of the lid. Operations for its relief have all been devised with the idea either of shortening the excessively long free border, by excising a V-shaped piece from its center, elevating and shortening by means of sliding flaps and excising tissue from the outer canthus, or supporting the drooping lid by attaching it to its fellow above.

Adams' Operation for Atonic Ectropion.

Of these ideas the removal of a triangular piece from the center is evidently the simplest, as it was the first attempted. Sir William Adams boldly excised from the center of the lid a wedge that included conjunctiva, skin and tarsus. He then closed the resulting notch by means of fine, interrupted sutures and a hare-lip pin. This operation removed the excessive tissue of the sagging lid but always left a prominent scar and frequently failed to heal properly at the lid margin, resulting in a disfiguring cleft.

The von Ammon Operation.

These facts led to the von Ammon operation, which strives to re-

move a part of the free border of the lid and still leave the remainder intact. To this end he took the gore cut from the entire thickness of the lid from the outer canthus, then closed the wound with the pin and sutures, as did Adams. (See the figures.)

The same principle was also utilized by Walther, who cut out a

Fig. 715.
Adams' Operation for Ectropion. (After Beard.)

triangular piece both above and below for the correction of cases of ectropion of both lids.

While removing the segment from the canthus instead of the center maintained the integrity of the remaining lid border it was so far removed from the punctum, the point which it is most desirable to restore to the normal position, that its result was frequently unsatisfactory.

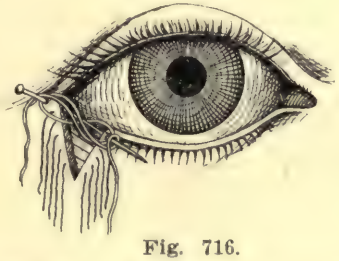


Fig. 716.
Von Ammon's Modification of Adams' Operation for Ectropion. (After Beard.)

Kuhnt's Operation for Atonic Ectropion.

In an effort to avoid these objections in the previous operations Kuhnt devised another modification of the Adams operation. (See Figs. 719-20.) A keratome is inserted between the skin and tarsus and the triangular piece of tarsus and conjunctiva thus liberated removed without cutting the skin. The edges of the cartilage and conjunctiva are then brought together and sutured, a proceeding that produces a fold in the skin at that point; and therein lies the weakness of the operation.

S. Mueller attempted to do away with this fold of skin by splitting the lid to the outer canthus, removing the wedge from the center of the tarsus, as did Kuhnt, and so arranging the sutures that the fullness of the skin was evenly distributed over almost the entire lid (as in Figs. 721-2.) This is in a large measure successful. Helmbold accomplishes the same end by splitting the lid and removing a V-shaped piece of tarsus from a point to the nasal side of the center of the lid, and a corresponding piece of skin from a point a little to the temporal side, so that the two clefts which are thus produced fall on dif-

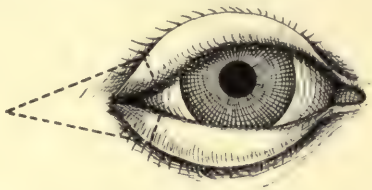


Fig. 717.
Walther's Operation for Ectropion. (After Beard.)

ferent points on the lid. They are sutured separately, then a few sutures placed in the lid margin.

Beard's Operation for Atonic Ectropion.

The author has successfully dealt with these cases of atonic ectropion by combining the idea of shortening the free border of the lid and at the same time holding the lower lid up by attaching the shortened, lower, tarsal cartilage to the external canthal ligament. In this operation a canthotomy is made in the regular way and the skin

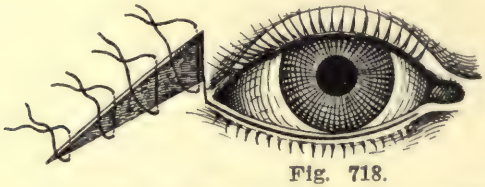


Fig. 718.
Kuhnt's Combined Operation for Ectropion.

incision slightly extended outward. The skin is then undermined below this incision and over the outer part of the inferior tarsus, and a portion of the outer end of the free border of the lid removed. The size of the piece cut away depends upon the excess of length of the lid and should contain the cilia. The outer extremity of the lower tarsus is then laid bare, seized with fixation forceps and, while skin and conjunctiva are retracted, a No. 2 silkworm or catgut suture is passed through the cartilage at a distance from the cut end proportioned to the length of the proposed shortening, and the superfluous

bit of tarsus cut off. A small triangle (base in) of integument and muscle is now cut from the upper lip of the canthotomy, exposing the external canthal ligament. Through this ligament is passed the suture just put into the lower tarsus, the two parts drawn together, the sutures tied, and the ends cut off short. The skin opening is closed by means

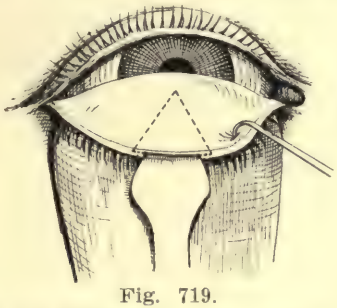


Fig. 719.

Kuhnt's Operation for Ectropion. First Stage. (After Beard.)

of fine silk sutures and the conjunctival wound left to itself. The buried suture is afterward absorbed or encapsulated.

Dieffenbach's Operation for Atonic Ectropion.

Shortening the lower lid by drawing it to the outer canthus without sacrifice of any considerable part of the tarsus was an idea introduced by Dieffenbach in 1838. His plan was to remove from the region of the outer canthus a section of skin (and muscle) shaped like an

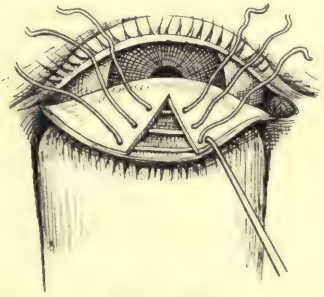


Fig. 720.

Kuhnt's Operation for Ectropion. Second Stage. (After Beard.)

equilateral triangle, with apex down and horizontal base on a level with the outer commisure. The length of the base of this triangle is equal to the excess of length of the free edge of the sagging lid. Through the opening made by the removal of this triangular piece the skin of the lower lid is undermined well past its center and down to a level of the apex of the triangle. The outer edge of the lower lid is now evenly pared off for a distance corresponding to one side of

the triangle, the external canthal ligament of the lower lid severed so as to allow the loosened skin and tarsus to be slid outward, and the denuded triangle closed. Thus the raw edge of the lid margin is

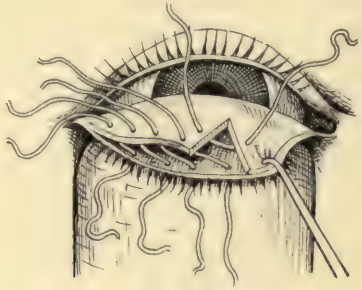


Fig. 721.
Müller's Operation for Ectropion. First Stage. (After Beard.)

brought into apposition with the base of the triangle and the "slack" in the lower lid taken up.

Fig. 722.
Müller's Operation for Ectropion. Second Stage. (After Beard.)

This disposition of the redundant lid edge was satisfactory in ordinary cases but in those of extreme degree the lid needed to be elevated as well as pulled over. This was attempted in a modification

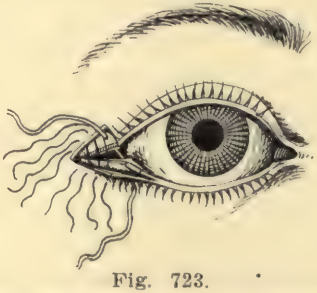


Fig. 723.
Beard's Operation for Atonic Ectropion.

of the operation of Dieffenbach which was designed by Szymanowski (Figs. 726-7), in which the triangular piece of skin removed from the

region of the outer canthus had its apex at the commisure and a short side extending up and out to a long vertical base. The third side was of intermediate length. This arrangement gives the procedure an

Fig. 724.
Dieffenbach's Operation for Ectropion. First Stage. (After Beard.)

added power of lifting the lid as well as pulling it over. It is also claimed that the resulting cicatrix has less tendency to displace the commissure than that in the original operation and that the effect may be more accurately graduated.

Fig. 725.
Dieffenbach's Operation for Ectropion. Second Stage. (After Beard.)

OPERATIONS FOR CICATRICIAL ECTROPION.

For eversion of the lid due to a slight and superficial scar the mere subcutaneous division of the restricting band, followed by strapping the lid in place with adhesive plaster and the application of a

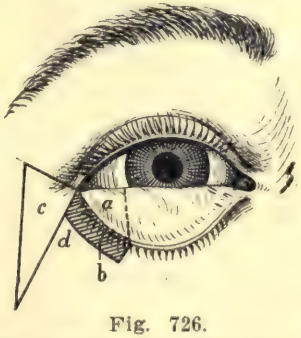


Fig. 726.
Szymanowski's Operation for Ectropion. First Stage.

compressive bandage, will sometimes give relief, especially if these measures are followed by vigorous vaseline massage and stretching of

the affected skin. But in the great majority of cases such simple means will not suffice.

As cicatricial ectropion is the result of loss of tissue, its surgical cure must necessarily involve replacing the lost substance. For this reason operations for the correction of these deformities will also apply in large measure for the relief of all conditions involving loss of substance of the lids, as from the removal of malignant growths,

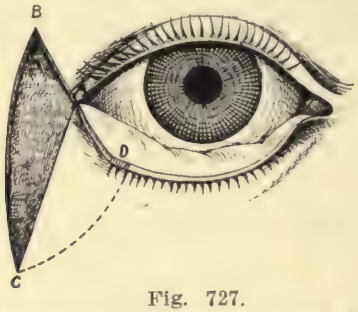


Fig. 727.

Szymanowski's Operation for Ectropion. Second Stage. (After Beard.)

burns or destruction from any cause whatever. Hence there will be no attempt made at separating these subjects into two distinct classes but the operations will be described and a choice must be determined by the particular indications in each individual case. They all involve the restoration of lost parts.

Dieffenbach's Operation for Cicatricial Ectropion.

For a lesion of moderate size, if not too near the commisure, an operation devised by Dieffenbach, or a very slight modification of it,

Fig. 728.

Dieffenbach's Operation for Ectropion of the Lower Lid. First Stage (After Beard.)

is still in common use today. Three straight incisions in the form of an inverted triangle are made around the affected portion, which is excised. From the corners of the base of the triangle are made two slightly curved incisions and the integument in the angles thus formed undermined. The skin all along the lower edge of the lid is dissected

up, the lid restored to its position and the edges of the incisions brought together in the form of a capital letter T. A more pronounced effect is obtained by combining the operation with an external tarsorrhaphy. This operation is suitable only for comparatively small lesions of the lower lid.

Fig. 729.

Dieffenbach's Operation for Ectropion of the Lower Lid. Second Stage. (After Beard.)

The Wharton Jones Operation for Cicatricial Ectropion.

For lesions of either lid the Wharton Jones operation, as modified by Sanson, may be used. From a point near the commissures two converging incisions are made which meet at some distance away from

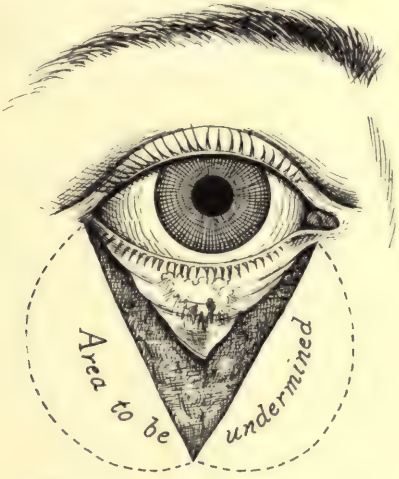


Fig. 730.

Wharton Jones' Operation for Ectropion. First Stage. (After Beard.)

the scar. The V-shaped flap thus made is dissected up to the roots of the cilia and the skin along the sides of the incisions freely undermined. The lid is restored to its position and the incisions united so as to form a Y.

Graefe's Operation for Cicatricial Ectropion.

Von Graefe devised an operation for correcting extensive cicatricial ectropion which was based upon the same principle—that of relieving the tension by loosening the cicatrix and drawing up the adjacent skin. From the commissures two vertical incisions are made, extending down on the cheek about 12 mm. An incision uniting these two is made along the intermarginal space and the lid split into two leaves, composed, respectively, of skin and muscle and tarsus and conjunctiva. The entire flap is then dissected up. The ectropion is now corrected by forcibly drawing up both the tarsal and skin segments and the skin flap is sutured to the borders of the vertical incisions for about the lower half of their length. The upper edge of the flap is

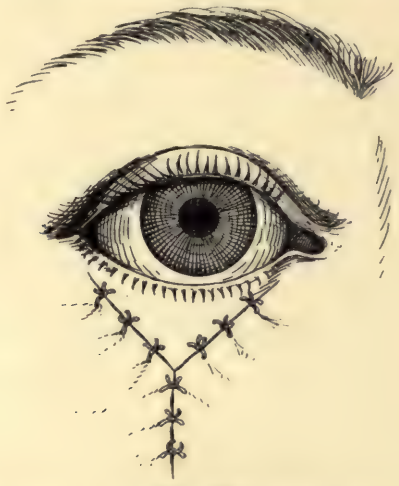


Fig. 731.

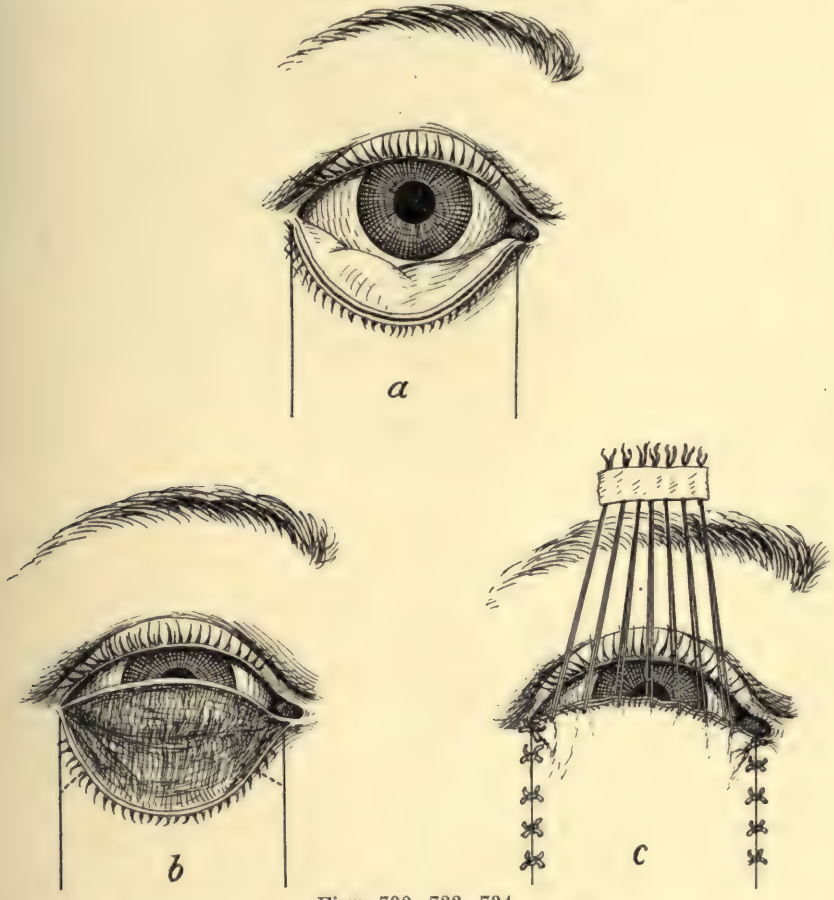
Wharton Jones' Operation for Ectropion. Second Stage. (After Beard.)

now trimmed to fit the border of the tarsus to which it is sutured, while the sutures are left long and fastened to the forehead by some such adhesive as collodionized cotton. A few shallow skin sutures, to close gaping edges, complete the operation.

Jaeger's Operation for Ectropion of the Upper Lid.

For *extreme ectropion of the upper lid,* where the free edge of the lid is drawn up almost to the supercilia, a method originated by F. Jaeger in 1831 is quite effective, though it might be improved by being slightly modified to conform to modern surgical ideas. He made an incision along the entire length of the lid close to and parallel with the ciliary border. The tarsus was then dissected free from the scar tissue and turned down into its natural position. Then the skin at the upper edge of the wound was freely undermined well onto the

forehead and out onto the temple, and the integument thus loosened was drawn down to cover the denuded lid, where it was secured by sutures. If the lid was too lax a V-shaped piece, embracing the tarsus and conjunctiva, was cut from the center of the lid and the edges firmly secured before the flap was drawn into place. This operation as originally performed necessarily produced considerable disfigurement by drawing the eyebrow down upon the lid, an objectionable



Figs. 732, 733, 734.

Graefe's Operation for Cicatricial Ectropion, *a*, *b* and *c*. (After Beard.)

feature that could be eliminated by covering the raw lid with a skin-graft or pedicled flap, as is usually done today. The triangular piece cut from the cartilage could also be advantageously taken from the outer canthus instead of the center of the lid, thus doing away with a scar immediately over the cornea and in a position where its contraction could produce a maximum amount of deformity of the lid.

Dieffenbach's Blepharoplasty.

For the restoration of an extensive defect of the lower lid, involving either the integument alone or the entire thickness of the lid, an operation originated by Dieffenbach in 1835 has stood the test of time. From the lower lid is taken a triangular piece of sufficient extent and thickness to remove the scar or other offending tissue, care being taken to preserve all of the healthy conjunctiva. An incision is now made extending horizontally outward from the canthus and of a length corresponding to that of the base of the triangle from which the skin was just removed. A second incision is made from the outer extremity of the first one equal in length and parallel to the outer border of the triangle. The flap thus formed is dissected loose and slid over to cover the defect in the lower lid. In Dieffenbach's day the denuded space which this transposition left was allowed to heal by granulation.

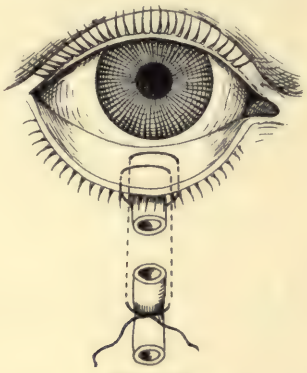


Fig. 735.

de Wecker's Procedure for the Relief of Ectropion of the Lower Lid.

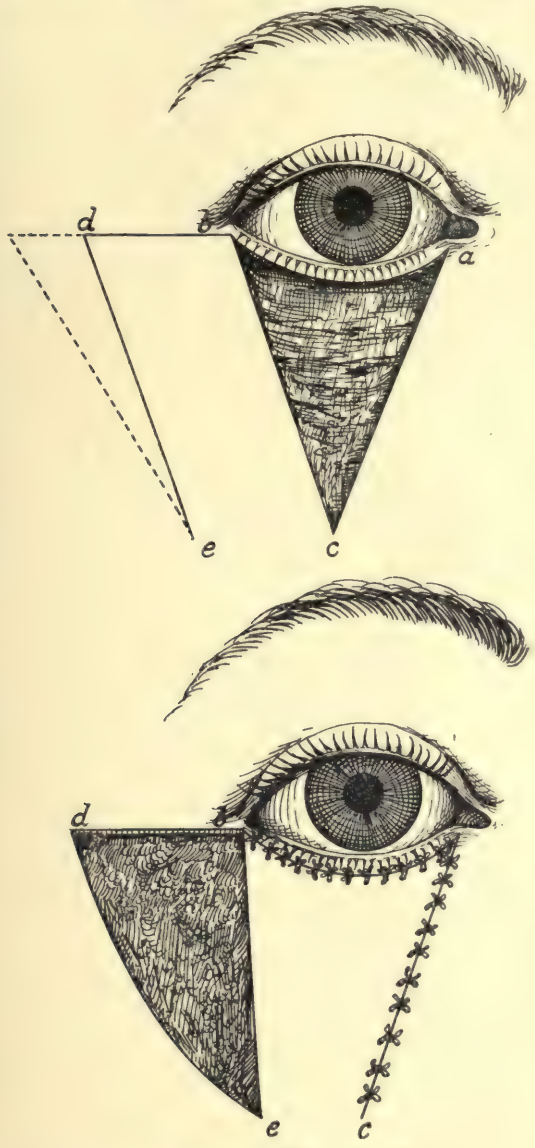
Today it would be covered by a skin-graft. Following a suggestion made by Angelucci the temporal incision may be extended well out toward the ear and the skin undermined and stretched over to cover much of this defect. This new flap must be held in position by means of adhesive strips attached to the bridge of the nose or forehead or by other means.

In order to have the secondary defect, with its inevitable contraction, farther removed from the eye Szymanowsky made the original triangle with a much broader base, as shown in the illustration.

The Kuhnt-Szymanowski Operation.

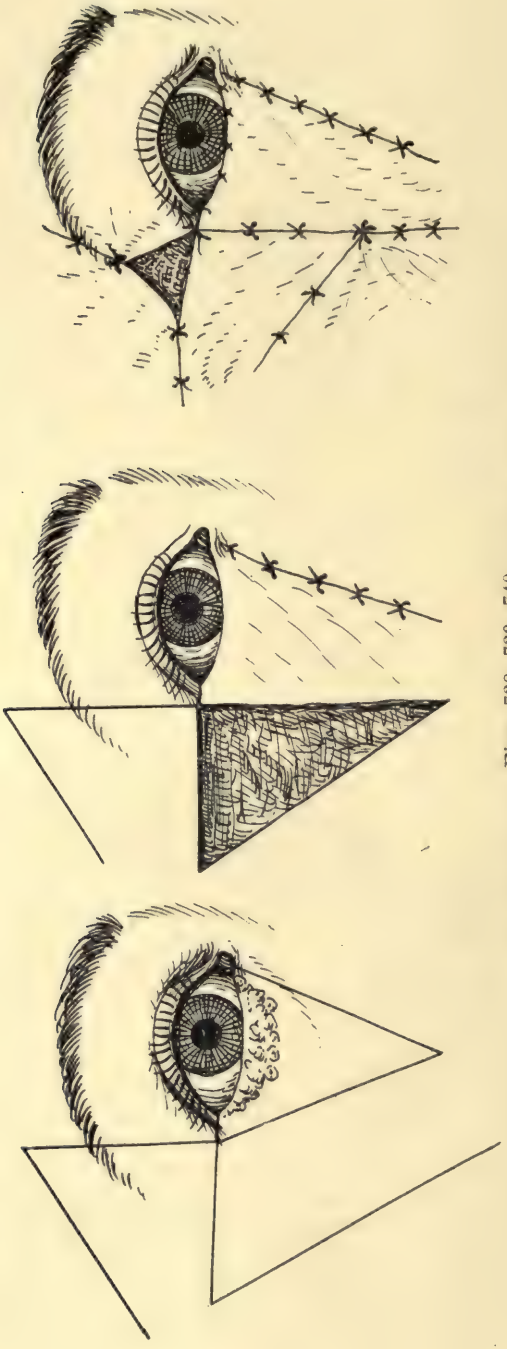
Kuhnt added to the Szymanowski operation by excising the outer end of the tarsus, proceeding as follows: Intermarginal incision whose length corresponds to the degree of shortening desired; canthotomy or skin incision, extending upward and outward the same

length as the intermarginal incision. This serves as the base line of the long triangle of skin, which is fashioned in a downward and out-



Figs. 736, 737.
Dieffenbach's Blepharoplasty, *e. g.*, in the Removal of a Growth. (After Beard.)

ward direction and excised. The inner side of this triangle is freely undermined. Straight, blunt scissors are inserted at the inner extremity



Figs. 738, 739, 740.
Harlan's Operation for Ectropion. (After Beard.)

of the intermarginal incision, where the tarsus and conjunctiva are divided vertically. The outer end of tarsus thus severed, together with its adherent mucous lining, is excised. The remaining tarsus is then moved bodily outward, closing the triangular skin defect, when, first, the opposing edges of conjunctiva and, lastly, those of the skin are united by fine sutures.

Harlan's Operation for Ectropion.

With the same end in view Harlan planned a rather elaborate

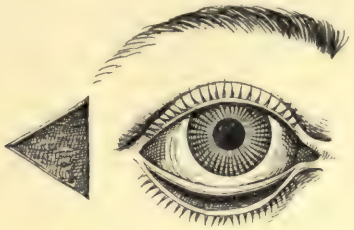


Fig. 741.

The Terson Operation for Ectropion. First Stage. A triangle of skin is excised from the temple and a strip of conjunctiva from the whole length of the lid margin.

operation in which he used two flaps in such a way as to leave little raw surface to be covered by a graft, and that so situated that its contraction produces no harmful effect on the eye. He contends that the flaps had better nutrition than would have been the case had their edges been left exposed, as in the other operations. He also asserts that the deformity following it is slight. Since it involves so many

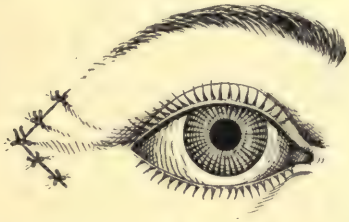


Fig. 742.

The Terson Operation for Ectropion. Second Stage. The incisions in the skin are brought together by sutures.

straight lines of sutures in prominent parts such a good result must demand most careful work on the part of the surgeon. The steps in the operation may be most easily understood from the illustration. After the flaps are dissected loose the borders of the denuded areas are freely undermined, so that their angles can be brought together and sutured before the flaps are slid into place.

Czermak's Modification of Dieffenbach's Operation.

For defects which involve from two-fifths to two-thirds of the horizontal measurement of the lid Czermak recommends a moderation of Dieffenbach's operation (q. v.). First, he makes a free canthotomy and extension outward of the incision for an equal distance through

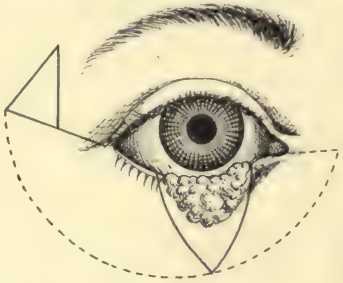
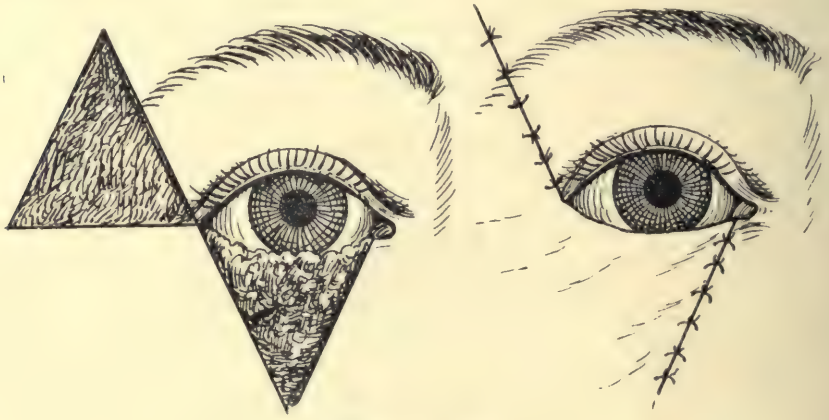


Fig. 743.
Czermak's Modification of Dieffenbach's Operation.

the skin of the temple; second, excision of the lid defect; third, undermining of the tissues of the lower lid down to the tarso-orbital fascia. From the outer end of the incision another is carried up and out; then another, beginning at the centre of the primary incision up and out, to meet the upper extremity of the second, and the triangle thus outlined excised.



Figs. 744, 744A.
Burow's Operation for Ectropion. (After Beard.)

Burow's Operation for Ectropion.

Another operation making use of triangular incision is that of Burow. (See the illustration.) It differs from those previously described, however, in that it sacrifices healthy skin and endeavors to accomplish the result by stretching instead of by transposition of flaps.

Here the triangle of healthy skin (Fig. 744) is excised and thrown away. A second triangular incision removes the offending tissue. The borders (Fig. 744A) of the denuded area are then freely dissected loose and the skin pulled over so that the sides of the triangles are in apposition. Only the most extensive undermining of these edges and the greatest care in providing for the relief of tension during the healing can make success possible in this operation. It is doubtful if it

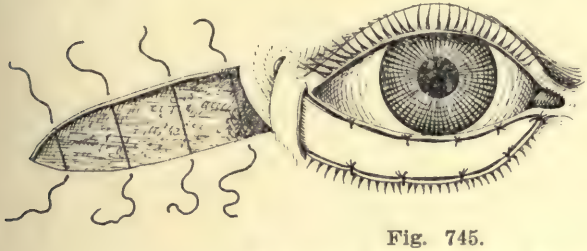


Fig. 745.
The True Operation for Ectropion.

should ever be selected where the entire width of the lid is involved so as to necessitate wide triangles, and seldom in any case.

Von Ammon's Operation.

It occasionally happens that ectropion is caused by a deep, circumscribed cicatrix with its long axis vertical to the lid and so firmly adherent to the bone that it cannot be easily excised. In such a case von Ammon surrounded the cicatrix (see the figure) by an elliptical

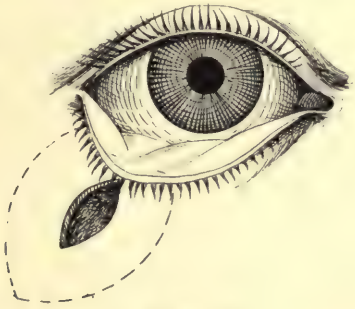


Fig. 746.
Von Ammon's Operation for Cicatricial Ectropion. (After Beard.)

incision and removed its surface to a sufficient depth to allow the adjacent skin,, which was now undermined, to be drawn over it. Free dissection should be made all about the opening so as to sever any cicatricial bands that hold down the lid. The lid is now righted and held in place by the closure of the wound, which is secured by a few interrupted sutures.

Hotz's Blepharoplasty in Ectropion.

Since the free border of the lid offers little or no resistance to the shrinking of the graft it is here that the baneful effect of its contraction is most pronounced. The larger the graft, the greater the subsequent shrinking and displacement. In order to divorce the free border from as much of this contraction as possible Hotz has divided the wound area into two sections, one representing the bared surface of the lid proper and the other that beyond the lid, each of which he covered with a separate graft. Before placing the graft in position the lid is put on the stretch and held there by strong silk threads which pass through the lid edge and are fastened by collodionized gauze to the brow or cheek, as the case may be. The lid graft is now implanted

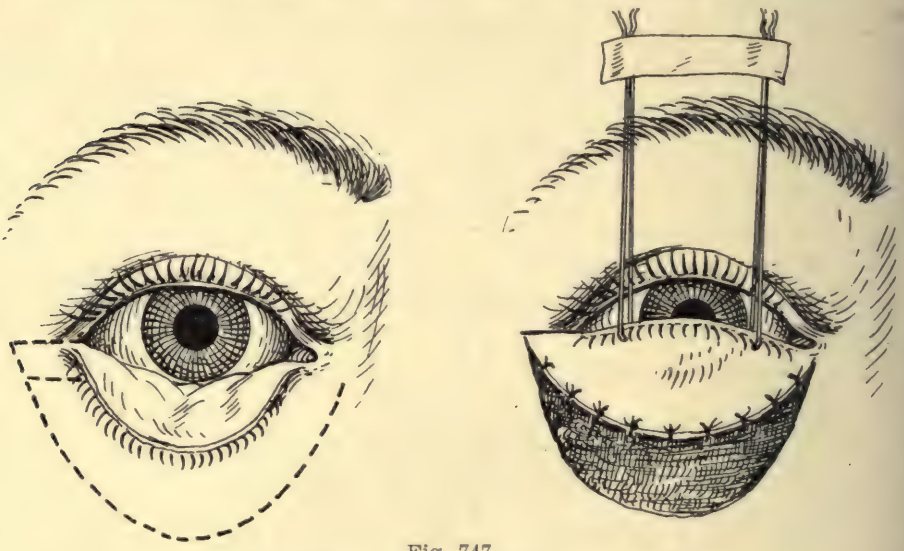


Fig. 747.

The Hotz Method in Blepharoplasty. (After Beard.)

and anchored by sutures but the graft on the other division of the bared space is left unsutured. By thus firmly supporting the lid he endeavored to overcome both the shrinking of the graft upon itself and its traction upon the free border.

The Terson and Truc operations for the relief of ectropion are depicted in the accompanying figures.

Cicatricial skin may occasionally be conserved and used to good advantage if it is adjacent to the lid border. In such a case Hotz, instead of dissecting out the scar and, covering the entire defect by one of the methods usually employed, dissected up the scar so as to make it a semilunar flap with its attachment at the lid margin still intact. Deep cicatricial bands which bound down the lid were then severed and the

Figs. 748, 749.
Knapp's Sliding-Flap Operation for Ectropion. (After Beard.)

lid turned up into position and secured by ligatures and collodionized gauze attached to the forehead. With the flap well relaxed its free border is made secure by a few sutures, while the remainder of the defect is covered by a Thiersch graft which is left unsutured. This

Fig. 750.
Lagleyze's Operation in Ectropion of the Lower Lid.

procedure is, of course, best suited to old scars whose contraction has practically ceased.

The *sliding-flap operation* is one of the simplest and most satisfactory methods for restoring part of a lid. The incisions are so situated that the resulting scars are inconspicuous, and after healing has once occurred there is little secondary change from contraction.

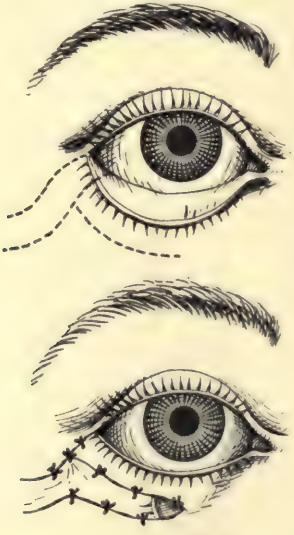


Fig. 751.
Tweedy's Operation for Ectropion.

The Knapp operation shown in the illustration is a good example of operations of this class. The relief of tension until healing has occurred is the important point in these operations and may be secured by means of adhesive straps or tension sutures.

Tweedy's Operation for Ectropion.

This seeks to shorten the lower lid by removing a section near the outer commisure and to utilize the segment thus removed in elevating the lid. This ingenious economy has been imitated by few.

In performing the operation a flap about 30 mm. long and 8 mm. broad is designed down and out from the external canthus. The incisions are continued through tarsus and conjunctiva until they meet in a point at the bottom of the cul-de-sac. The flap is then dissected up to its base. An incision is now made below and parallel to the lid border, extending through the skin and orbicularis. This allows the lid to be drawn up into place and sutured at the canthus. The flap is turned into the secondary defect and secured by sutures.

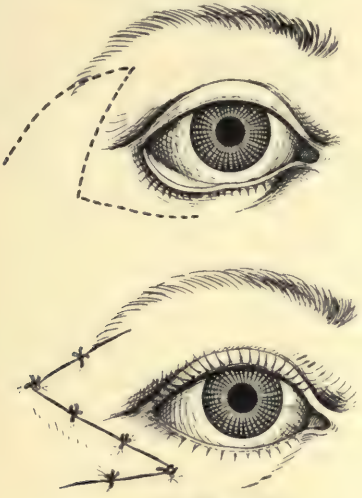


Fig. 752.
Denonvilliers' Operation for Ectropion.

Denonvilliers' Operation.

This operation for the elevation of the outer third of the lower lid makes use of the same principle of transposition of flaps utilized by Richet and others, with the difference that the lines of his incisions are almost straight instead of curved, and the operation is purely a transposition as it does not replace lost parts. Its use is very limited since it does not do away with the redundant tissue, replace scar tissue or shorten the lid. It also necessitates several extensive incisions which are apt to prove disfiguring. It does not sacrifice healthy skin, however, a fault upon which many plastic operations may be indicted, and does elevate the outer part of the lid, but in order to hold the ciliary border in proper apposition to the globe it is usually necessary to combine a tarsorrhaphy with this operation.

Argyll-Robertson's Strap Operation for Ectropion.

It is efficient in selected cases. The author evidently kept in mind the two essential points in the correction of pronounced ectropion—

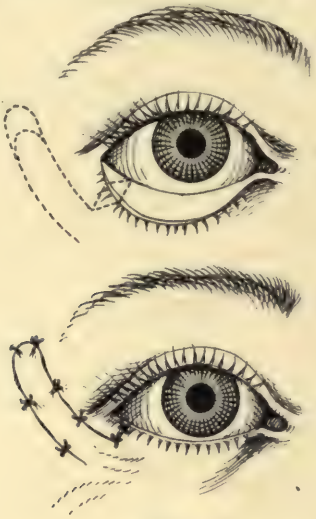


Fig. 753.
The Argyll-Robertson Strap Operation for Ectropion.

that is, the removal of the redundant lid edge and raising the shortened lid into position and holding it there. This operation is obviously

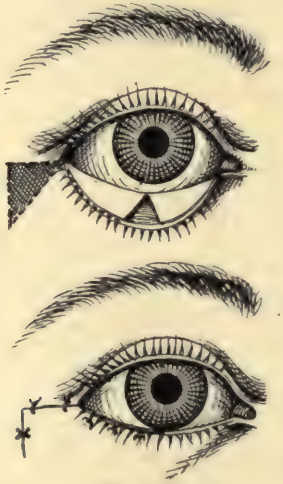


Fig. 754.
Combination of Kuhnt and Dieffenbach Operations for Ectropion.

suited only to those cases in which the eversion is most pronounced in the outer half of the lid. A short distance from the outer canthus

a wedge-shaped piece is removed which includes skin, tarsus and conjunctiva, and disposes of the excess of length of the lid ledge. To bring the cut edges into approximation and hold up the lid a strap is fashioned as shown in the illustration, the lid pulled up into position and the overlapping end of the strap cut off.

The Kuhnt Operation for Cicatricial Ectropion.

Here the excess of lid skin is drawn into a bunch in the center.

Fig. 755.

The Snydacker-Morax Method of Autoplasty. First Stage.

This generally disappears in time but may never be wholly obliterated. To overcome this objection some operators have combined the Kuhnt and Dieffenbach operations, taking the triangle of skin from the region of the canthus and the cartilage from the midddle of the lid. Such a procedure, of course, necessitates separating the skin and orbicularis from the tarsus at its outer half. The wound in the cartilage and conjunctiva is united with sutures and the skin-fold left by the old operation obliterated by drawing it out toward the canthus.

Helmbold accomplished the same end by removing a triangle of skin corresponding to the triangle of cartilage, but further out, splitting the lid between them. The two clefts thus made were sutured separately. These methods are especially applicable to cases where a small scar may be included in the incised skin.

Kenneth Scott's Operation for Ectropion.

This is best suited for cases of atonic ectropion characterized by

Fig. 756.
The Snydacker-Morax Method of Autoplasty. Second Stage.

a moderate degree of drooping of the lid. It is extremely simple and, in suitable cases, just as effective as some of the more disfiguring and elaborate procedures. A free external canthotomy is performed and the lower lid freed from the external canthal ligament so as to allow it the greatest degree of mobility. The lid is now stretched out sufficiently to restore it to its normal position and the part of the lid edge which extends beyond the canthus is cut off. The angle of this newly

formed canthus is now secured with two silver wires which are removed in ten days. The remainder of the wound is sutured with fine silk which is removed in three or four days. This proceeding will, of course, leave a bunch of skin at the lower border of the canthotomy. However, this usually disappears in time and if it does not may be easily remedied at a subsequent operation.

Snydacker's Method of Autoplasty.

In 1905, Snydacker, of Chicago, presented to the Ophthalmo-

Fig. 757.
The Snydacker-Morax Method of Autoplasty. Third Stage.

logical Society of that city the first subject of his operation. By it the disfiguring scars consequent upon obtaining the flaps from the immediate vicinity of the eye are avoided. Moreover, it is especially applicable to those cases in which extensive cicatricial areas in that vicinity render them unavailable for blepharoplasty. The essential feature consists in fashioning a flap from the skin overlying the sterno-

mastoid muscle, with its base beneath the ear and of sufficient length for its free end to reach the inner extremity of the lid defect and cover the latter. The neck defect is readily closed by undermining and suturing, leaving an inconspicuous linear cicatrix. When the portion covering the lid defect is firmly adherent the long pedicle is abscised.

Morax, of Paris, has recently utilized a modification of Snydacker's operation for the restoration of extensive destruction of the skin in the palpebral and superciliary regions which he calls *autoplasty with pedunculated cervical flap in two sittings*. Supposing the area to be restored comprises both lids or a rather extensive part of the fronto-palpebral region, Morax at the first sitting proceeds as does Snydacker, repairing say one-half, or less, of the destroyed surface. Then at the expiration of 12 to 15 days, when the circulation is well established in that part, he prepares the remainder of the area, freshens and makes aseptic the unattached portion of the flap, after having severed it at

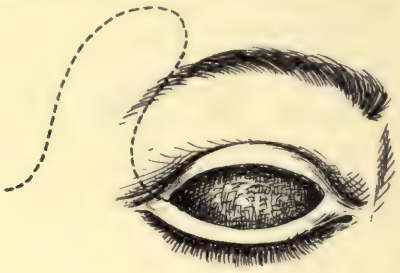


Fig. 758.
Fricke's Operation for Cicatricial Ectropion. (After Beard.)

its base, trims, turns, and otherwise adjusts and sutures it so as to complete the desired restoration.

THE INDIAN METHOD. TRANSPLANTATION OF PEDUNCULATED FLAPS.

This method of replacing lost parts was first practised by the ancient Hindu surgeons who used it for the restoration of the nose. In the latter part of the nineteenth century it was adapted to plastic surgery of the lids and the first successful case was reported by von Graefe in 1858. It was adopted and extensively used by Fricke, whose success brought it into immediate popularity. His good results were perhaps due to the fact that he limited its use mainly to cases of cicatricial ectropion, where only the superficial tissues had been destroyed and the tarsus and conjunctiva merely displaced. The broad base which he gave to the flap was also a factor in the good results, for the base was made broader than the body of the flap, which guaranteed its good nutrition. The operation was performed as follows: An

incision was made at the distal edge of the cicatrix and parallel with the border of the lid. The scar tissue was removed and the tarsus dissected loose from the adhesions and restored to its normal position. A flap, about one-third larger than the oval raw surface thus produced, was cut from the forehead and temple and twisted upon its base sufficiently to fit it into the defect in the lid. If necessary, one corner of the base was trimmed so as to allow the flap to lie smoothly in piace

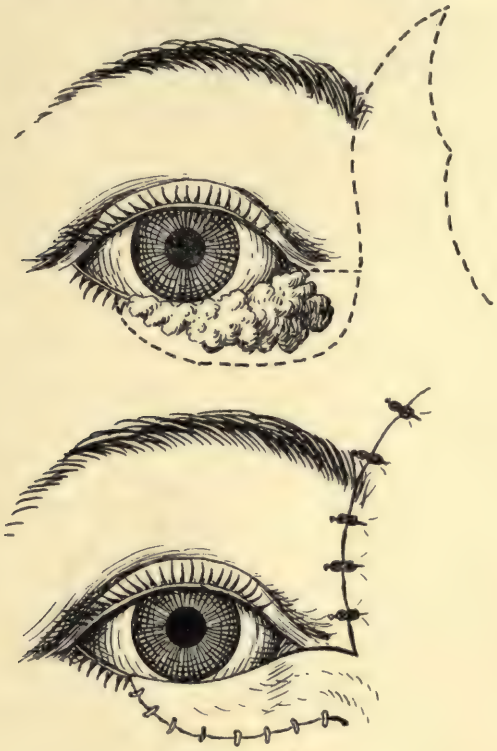


Fig. 759.
Blasius' Operation for Entire Lid Restoration. (After Beard.)

and it was then sutured in position. Fricke left the wound from which the flap was taken to heal by granulation. Today it is usually closed by one of the methods of skin grafting—sometimes combined with undermining the edges of the wound and drawing them as nearly together as possible. The peculiarities of each individual case must determine the shape of the flap and the region from which it is taken, as well as minor changes in the operation.

Blasius' Operation for Restoring a Lid.

This same principle was used by Blasius as early as 1842 for the

Figs 760, 761.
Another Form of Blasius' Operation for Restoring the Entire Lid.
(After Beard.)

restoration of the lower lid—the flap being taken from either the nasal or temporal side, as seemed more expedient. Only a flap of limited size can well be cut from the region of the forehead, however, so when an unusually large flap is demanded in restoring the lower lid it may be

Fig. 762.
Denonvilliers' Flap Method of Blepharoplasty. (After Beard.)

taken from the cheek after the method of Denonvilliers. This, of course, leaves a large denuded area in a position where it is apt to produce a disfiguring scar, to avoid which Fauk has taken the flap from well down on the neck and transplanted it to the lid by using an extremely long and narrow pedicle, which of course militates against

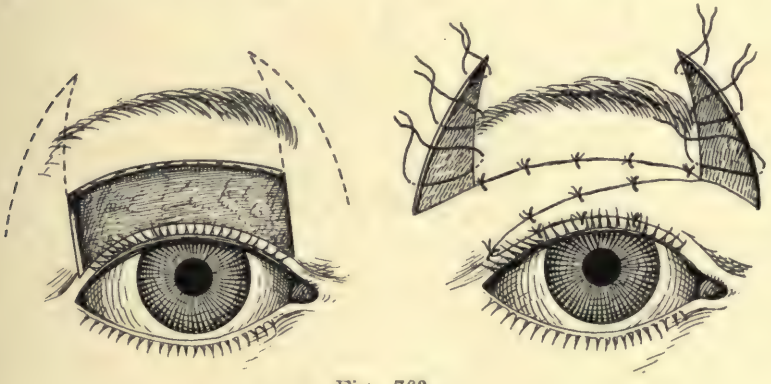


Fig. 763.
Rollet's Blepharoplasty.

chances of its surviving, even if it were not bridged across an interval of intact skin. When the flap has taken, the pedicle is of course cut away. This operation leaves only a slight scar and that in an inconspicuous place, but it is questionable if this extremely long pedicled bridged flap has any advantages over a simple Wolfe graft.

Hasner's Blepharoplasty.

Canthal defects involving both lids have produced a class of operations for their relief of which Hasner's is typical and was perhaps the first, and is also one of the most satisfactory. Instead of a simple flap, the distal end of it is bifurcated in such a manner as to best meet the indications. In repairing the inner canthus it is best to take the flap

Fig. 764.
Richet's Blepharoplastic Method.

from the naso-maxillary region, since one taken from above usually contains hairs that are both disfiguring and troublesome in their new location.

For lesions in the neighborhood of the commissure but not involving it Richet's operation is sometimes used. If the tarsal cartilages are much distorted it may be necessary to do a provisional tarsorrhaphy

in order to get them back into place and to retain them, by means of suitable dressings, during the early stages of the healing process.

The other steps in the operation are best explained by the illustrations.

Rollet's operation is illustrated in the text.

BLEPHAROPLASTY BY MEANS OF DOUBLE PEDICLED FLAPS.

Another class of operations includes taking a strip of tissue from the forehead (leaving both ends attached) to replace the upper lid.

This method was first practised in 1879 by Businelli, who took a flap from the forehead, with a pedicle near each end of the eyebrow, to replace the skin and to correct complete ectropion of the upper lid—precisely what has been more recently done by Lagleyze of Buenos Aires—and here it has served admirably.

Landolt modified it by taking from the upper lid the integument to repair a defect in the lower. The great advantage this method

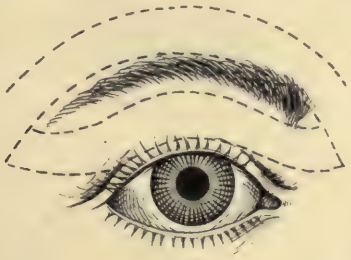


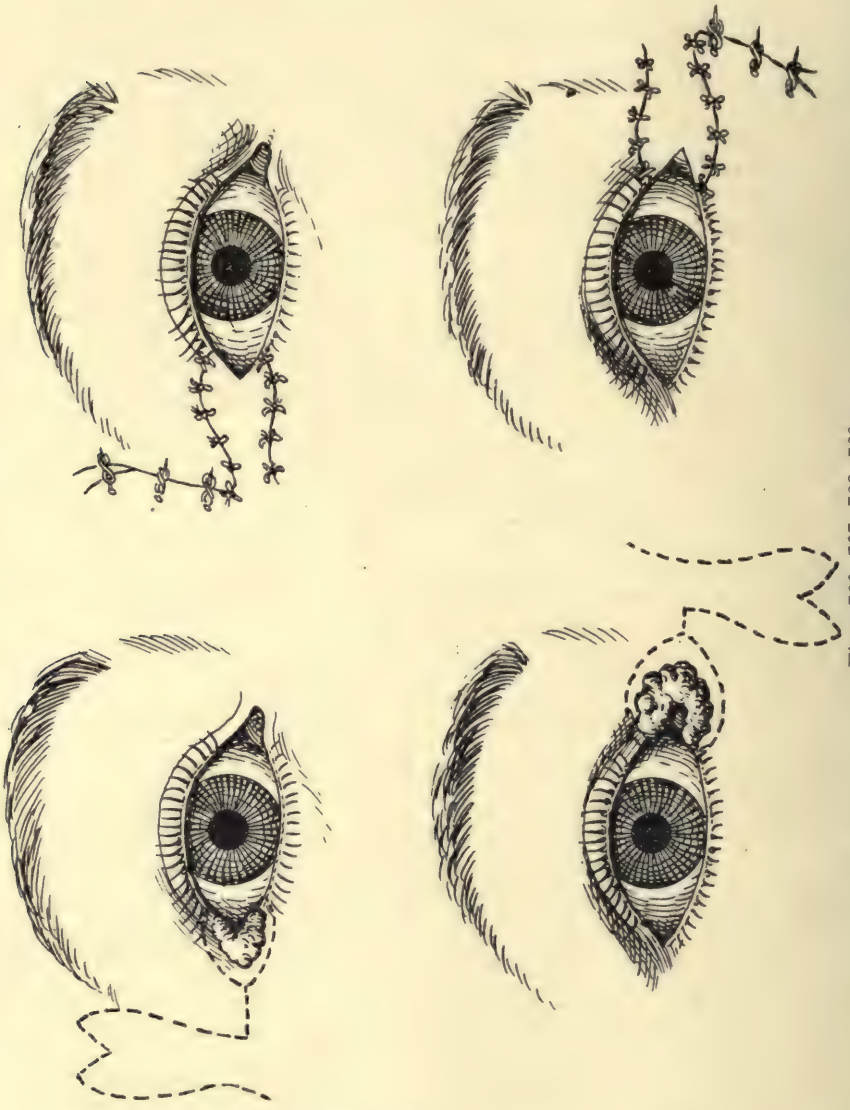
Fig. 765.
The Incisions in the Businelli (1879) Operation. (Beard).

has over others is that the flap, being attached at both extremities, is better nourished, which is especially advantageous when the defect to be filled in is long and narrow. The thickness of the skin flap thus obtained is also better suited for the purpose than that from other regions. It is permissible only where a narrow graft would fill the requirements, for a wide graft removed from the healthy lid, together with its subsequent contraction, results in undue shortening.

The illustration explains *the operation as practised by Landolt.* The upper lip of the wound in the upper lid is extensively undermined and the skin drawn down and sutured to the lower. When the growth of the graft is well established the pedicles are severed and the ends trimmed off.

It would seem that the indications for such an operation as this would rarely occur, since a flap so narrow as not to endanger the lid from which it is borrowed would be almost obliterated by the shrinkage that follows its transplantation. Still more rarely would one be jus-

tified in following the example of Panas by taking single-pedicled flaps from one lid to restore the other. In his operation he usually performed a provisional tarsorrhaphy.



Figs. 766, 767, 768, 769.
Hasner's Blepharoplasty for Restoring Loss of Tissue at Either Canthus.
(After Beard.)

The Italian Method. Heteroplasty.

This operation, in which pedicled flaps are taken from remote parts of the body, was devised and used by Branca, a Sicilian surgeon, several hundred years ago. According to the custom of that period knowledge of the operation was handed down from father to son so

that it was practised by members of that family for many years. In 1597 Gaspard Tagliacozzi wrote a treatise on the operation, hence it is sometimes called the Tagliacotian method. It was used by these early surgeons for the restoration of the nose and was performed by removing the integument from the part to be reconstructed and fashioning a skin flap from some part of the arm or leg and allowing both to granulate. After about three weeks the granulations were freshened and the flap brought into place by binding the limb bearing it securely to the head. When union was established the pedicle was cut and the limb released. On account of the severity of the operation and the time required to accomplish its object, it fell into disuse for many years, to be revived in 1816 by Carl Ferdinand Graefe, who employed it for restoration of the lids. He modified it by uniting the

Fig. 770.

Landolt's Double Pedicled Flap Operation for Restoration of the Lower Lid.

raw surfaces immediately, instead of waiting for granulation to occur. Even this improvement, which greatly lessened both the inconvenience and time required for healing, failed to make the operation a popular one.

Berger's Modification of the Italian Method.

Between the years 1879 and 1889 it had another revival at the hands of Paul Berger, of Paris, who performs the operation in the following manner: A leather corset, collar and cap, articulated with laces and straps and strengthened with steel braces, are fitted to the patient's head and body. On the forearm is laced a leather gauntlet provided with straps by means of which it can be immediately attached to the head at the proper stage of the operation and the arm

fastened firmly to the head. (See the illustration.) To test the immobility of the parts the dress should be worn and the patient kept in bed for a few days before the operation and alterations made until the

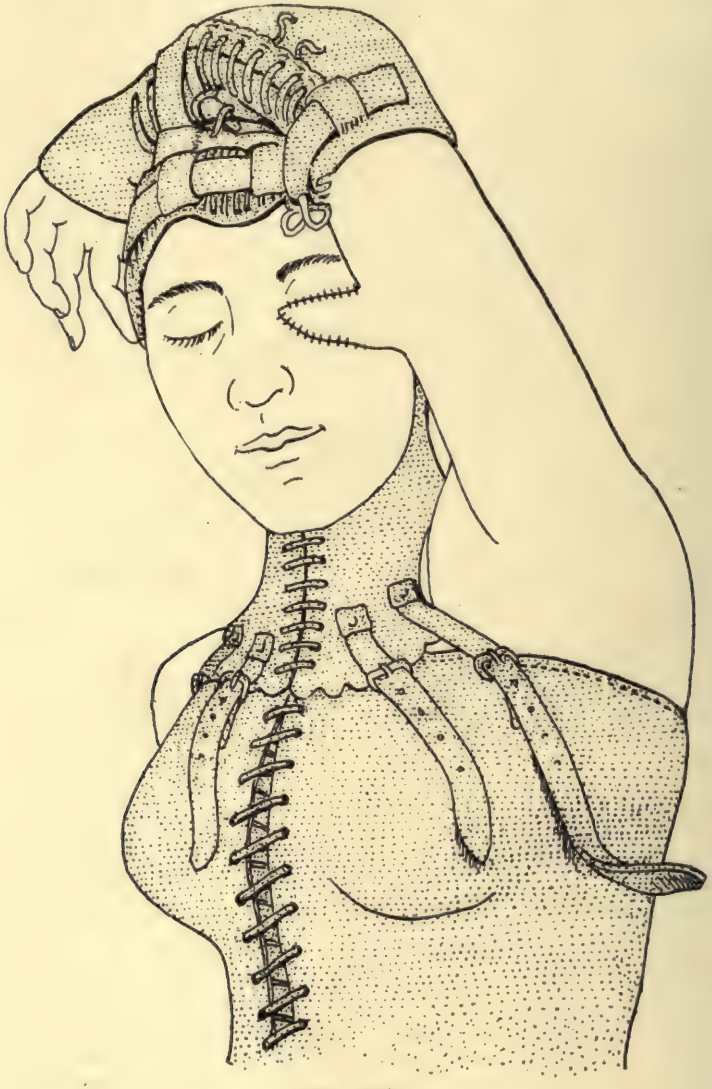


Fig. 771.
Berger's Adaptation of the Italian Method of Heteroplasty.

limb is held perfectly secure. This will also accustom the patient to the confinement and constraint which must be endured. An exact pattern of the lid defect is cut from oil silk or court plaster, the arm

from which the graft is to be taken is then brought up to the eye and the spot which makes the easiest and most natural contact is chosen as the site of the pedicle. The pattern is then applied in such a position that the pedicle of the graft will be as little distorted as possible, and the graft outlined one-third larger than the pattern. The graft is excised in the usual way, the fat removed, and all hemorrhage stopped. The pedicle is slightly loosened, that the nourishing vessels may be free from torsion or pressure. The wound on the arm is dressed and the arm strapped into position. The flap is applied to the raw surface of the lid wound and held by a few fine silk sutures. Near the pedicle a few deep tension sutures are placed to resist involuntary pulling from the arm. Adhesive strips may also be used to advantage. The eye is dressed as in other flap operations and is given the same after-treatment; at the end of a week the pedicle may be divided.

Berger tried plaster moulds for holding the arm in place while the graft was taking but found them too big and cumbersome and that they added to the patient's discomfort by masking the face.

More recently, however (in 1905), Lagrange, of Bordeaux, has had recourse to this mode of fixation of arm and head. He declares a properly constructed plaster mould to be equally as effective as the Berger apparatus in this particular; and, it goes without saying, that it has the advantage of being infinitely cheaper. It can be so padded, both in the original application and (particularly) afterward, as to render it more bearable, and it may be cut away about the face sufficiently to obviate objection.

Lagrange employed it in the restoration of both lids, everted from extensive burn of the face and neck. The mould was put on several days before the operation and worn for a short time that both patient and surgeon might know what to expect from it. When finally applied it was trimmed so as to interfere least with its usefulness. As soon as the primary dressing of the tarsi was accomplished, median tarsorrhaphy was resorted to and this was not divided till after the expiration of eight months. The mould was removed on the tenth day.

For the first few days the patient should remain in bed and be constantly watched by an attendant. Opiates or bromides may be given, if necessary to calm excessive nervousness or restlessness incident to the long-continued and unwonted position of the parts. At the end of the fifth day he may be propped up in bed and in a few days be allowed to cautiously walk about. The success of the operation depends largely upon ability to keep the parts quiet. If this can be accomplished it offers the same excellent chances of success as other pedunculated flap operations.

BLEPHAROPLASTY FOR THE RESTORATION OF A PORTION OF THE ENTIRE EYELID.

If the entire surface of the lid has been destroyed its satisfactory restoration by means of pedunculated flaps or otherwise can seldom be accomplished. While the skin surface may be replaced, the tarsus and conjunctiva are absent and in their stead is a surface of scar tissue whose continual contraction against the unresisting new lid will sooner or later draw it into a rolled up, shapeless and useless mass which performs no protective function, but whose rough borders rub against and irritate the cornea. Efforts to overcome this tendency have been rewarded with a very scant measure of success.

Budinger makes use of a section cut from the ear, including the cartilage and skin of the posterior surface. This is placed on the raw surface of the restored lid at the time of operation, or at a secondary operation after the nutrition of the new lid has been well established and before its cicatricial lining has begun to contract. This operation substitutes skin for mucous membrane and the removal of the graft from the ear is apt to produce deformity of that organ. The author's associate, Dr. Charles Clement, suggests that possibly some of the portions of the cartilaginous nasal septum, with its mucous covering, could be thus utilized. So also could the tarsi and adherent conjunctiva of certain of the lower animals.

Restoration of cul-de-sacs with epidermal lining may be successfully undertaken at a much earlier period than that to restore the outward parts of the lids.

Goyanes' Operation for Restoration of the Eyebrow.

A horizontal incision is made through the middle of the healthy brow dividing it into two equal parts. A second incision, a short distance above the brow, divides it from the skin of the forehead. These lines are continued so as to form a broad based flap above the nose. The defect on the other side having been suitably prepared to receive the flap it is dissected loose and turned into its new position where it is sutured into place. The skin of the forehead is freely undermined above the secondary defect and pulled down and sutured to the remaining half of the brow. It is held in place by adhesive strips until union is established, to prevent displacement of the brow, although slight elevation is not undesirable. The flap should not be too thin as it is more apt to perish.

[Figures showing steps of this operation will be found on page 1399.]

OPERATIONS FOR THE RELIEF OF SYMBLEPHARON.

Definition.

Symblepharon is a term used to distinguish any union between the lids and globe. This union may vary in extent from the smallest,

thread-like bands which join the ocular and palpebral conjunctiva, to those extensive adhesions in which the entire cul-de-sac is destroyed and the globe and lids immovably bound together. By different authorities it has been classified as outward, inward, upward, downward, an-

Fig. 772.
Anterior or Circumscribed Symblepharon.

terior and posterior, according to its location, and partial or complete according to its extent.

Under the head of symblepharon is usually included also those cases where the conjunctiva, sclera and tarsus are involved in the ad-

Fig. 773.
Posterior or Partial Symblepharon.

hesion which binds them into an immovable mass, or an *ankyloblepharon*.

The division into *anterior* and *posterior symblepharon* is the classification most commonly adopted. Anterior, or circumscribed, symblepharon is the simplest form and refers to those cases where the junc-

tion between the opposing portions of conjunctiva does not reach the fornix.

Posterior or *partial symblepharon* includes those cases where the adhesion does extend into the fornix. This term is also sometimes applied to a partial obliteration of the cul-de-sac which results from gradual shrinking, as that following trachoma or pemphigus.

Total or *complete symblepharon* includes the pronounced cases, where the attachment involves the whole of one or both lids and the cul-de-sac is utterly effaced.

Etiology.

Symblepharon may be produced by any lesion which denudes opposing surfaces of the palpebral and ocular conjunctiva. Burns from

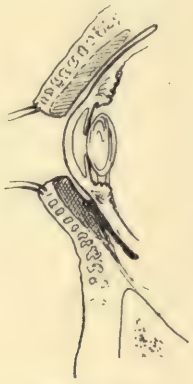


Fig. 774.
Obliteration of the Cul-de-Sac from Shrinkage.

lime, molten metals or acids cause the larger percentage of the cases, while wounds, ulcerations, trachoma, diphtheritic or gonorrheal conjunctivitis, or xerosis, and the effects of operation are the commoner causes of the remainder.

The *indications for or against surgical intervention* are usually plain. Any adhesion of sufficient extent to limit the excursions of the globe, to cause pain, or to constitute a cosmetic defect can usually be relieved or improved by an operation. The restoration of a completely or partially obliterated cul-de-sac to provide for the wearing of a prothesis is included under this head. Operation is contraindicated so long as contraction is still active in the adhesions if the fornix is involved. So long as there is no involvement of the fornix the case presents no especial difficulties and may be operated upon at any time. The more extensive the involvement of the fornix the more formidable becomes the operation and the smaller the chances of ultimate success, (hence

the necessity of awaiting the most favorable moment when all activity in the adhesions has ceased) so that the relief of total symblepharon has always been considered a difficult and, sometimes, a hopeless task. With the improved methods introduced during the last few years the prognosis has become somewhat more favorable.

The same procedures for the covering of raw surfaces and the obliteration of adhesions in other parts of the body are available here—only slightly modified on account of the delicacy of the structures involved. The means employed are, (1) severing the adhesions, (2) sliding flaps of conjunctiva, (3) pedicled flaps of conjunctiva or skin, and (4) grafts, cutaneous or from the conjunctiva of both human and lower animals.

For *symblepharon of limited extent and not involving the fornix* it is usually sufficient to sever them close to the globe and prevent re-

Fig. 775.
Total or Complete Symblepharon.

attachment by passing a probe between the cut ends at frequent intervals until healing is complete. If the cornea is involved the bridge must first be carefully dissected away. If the adhesion has been of sufficient size to leave a gaping wound in the ocular conjunctiva it may be closed by a silk suture. The remnant of the cicatricial band which hangs as a tag from the lid is not cut off immediately but is allowed to remain until healing of the bulbar wound is complete, when it will frequently have disappeared. If not, it may now be severed and seldom requires sutures. Adhesions of this kind rarely offer much difficulty in their obliteration. It is those that involve the fornix that are prone to recur in direct ratio to their extensiveness.

Arlt's Operation for Symblepharon.

Of the symblephara that include the retrotarsal folds the commonest form is what is known as the *columnar type*, in which a thin

band of adhesion reaches from the fornix for a variable extent up to or involving the cornea. For its relief many operations have been adopted, but that of von Arlt (Fig. 776) is the one most commonly used. It is performed as follows: If the cornea is involved this portion of the adhesion is grasped with delicate, sharp-toothed forceps and carefully dissected away with a keen-edged scalpel. Some operators prefer first to pass through the apex of the adhesion a double-armed suture by which it may be held instead of with the forceps. This suture should be so inserted as to have the loop lie upon the outside of the adhesion, as it can thus be best utilized when the apex of the cicatrix is buried, in a later stage of the operation. The apex having

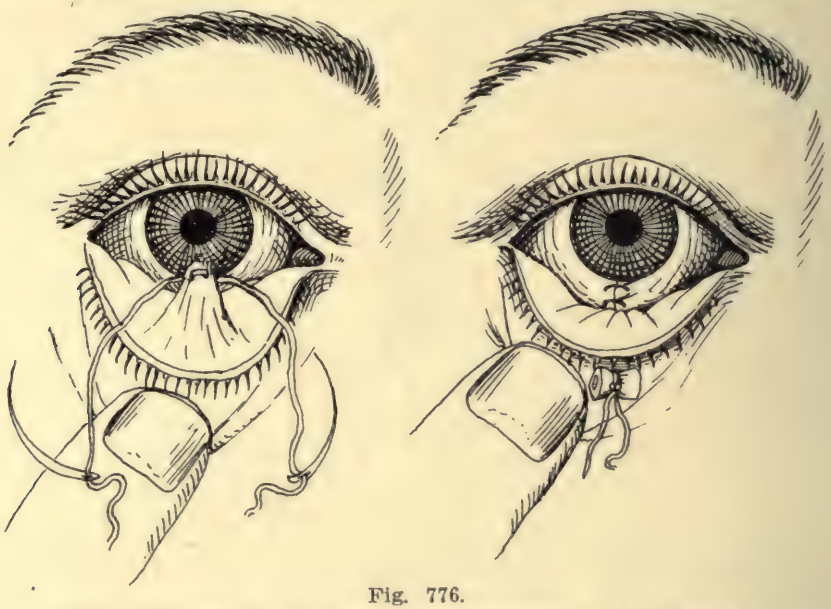


Fig. 776.

Arlt's Operation for the Relief of Symblepharon. (After Beard.)

been freed from the cornea, the adhesion is abcised from the globe by blunt, curved scissors, after which the scar tissue is completely cut out of the loosened bulbar conjunctiva by two incisions made from its apex to its base. This leaves the adhesion a freed tag, or flap, which is turned into the opening at its base and secured by sutures which pass out through the entire thickness of the lids and are tied over a small roll of gauze or piece of rubber tubing. The edges of the bulbar wound are freely dissected loose, or undermined, with blunt scissors, and then united with fine silk sutures. If the corneal involvement has been extensive it may be necessary to cut the conjunctival flaps free for a short distance around its edge, to secure good coaptation.

Especial care should be taken to close the wound in the bulbar conjunctiva well down into the fornix, as it is there that recurrence is most apt to take place. The turning of the tag into the lid produces a pronounced bunch of scar tissue and conjunctiva which, however, usually disappears in time.

Teale's Operations for Symblepharon.

Instead of dissecting the apex of the symblepharon off the cornea it may be simply severed from the body of the scar at the limbus and the corneal portion allowed to remain in position where it usually undergoes some degree of atrophy. This idea was first advocated by Teale in 1861. The same surgeon also devised several flaps for covering the raw surfaces left by the removal of extensive scar tissue. In one he took vertical flaps from either side of the cornea and turned

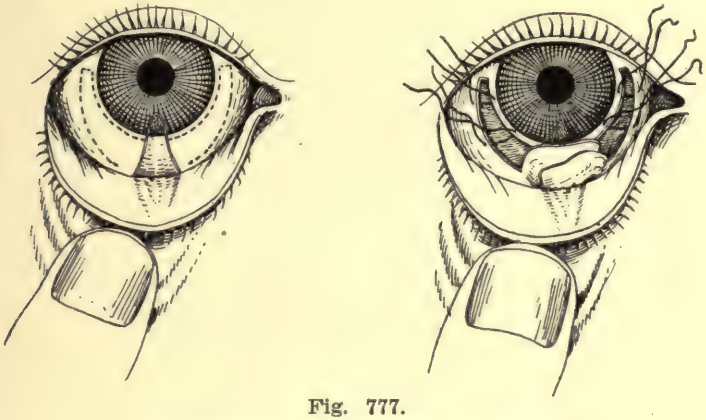


Fig. 777.
Symblepharon. Operation of Teale.

them upon their pedicles so as to lie horizontally across the wound, where they were sutured into place (see the illustrations). The secondary defects were then closed by drawing the edges together and suturing them.

At a later period he made an arched bridge flap from the healthy conjunctiva opposite the symblepharon. This bridge was left attached at both ends, slid over the cornea and sutured into position where it covered the denuded surface left by the removal of the symblepharon.

The Teale-Knapp Operation for Symblepharon.

This procedure combines certain features of the methods of von Arlt and Teale. The pterygoid apex of the symblepharon is cleanly dissected away from the cornea and buried in the sulcus after the manner of Arlt, while the bulbar wound is covered as in the Teale pro-

cedure. The lower edge of the newly adjusted conjunctiva is firmly sutured into the fornix to prevent its riding upon the raw area of the cornea and producing an opaque scar. To prevent this Schirmer grafted onto the human eye a thin layer of the cornea of a rabbit.

Fig. 778.
Teale-Knapp Operation for Symblepharon.

Burying the freed end of the symblepharon in the fornix is theoretically a satisfactory way of disposing of it, but for some unaccountable reason this buried mass is prone to gradually push its way up and nullify the good primary result of the operation. Various expedients have been tried to overcome this tendency. Panas made a buttonhole in the lower lid through which he carried the detached apex and buried it beneath the skin of the cheek, but with such indifferent success that his example is seldom followed.

If there is much dense scar tissue deep in the fornix it is well to remove as much of it as possible, because the more dense the tissue the more apt is it to cause trouble after it is buried.

Himly's Symblepharon Operation.

Since anterior symblepharon is so easily overcome and the removal of posterior symblepharon is encompassed with such difficulty, Himly attempted to first transform the posterior into the anterior type and then operate on the latter, simple form. To accomplish this he pierced the adhesion along the fornix and introduced a large lead wire, which was allowed to remain in position until the opening had become lined with epithelium, as is done when the ears are pierced. This measure was only partially successful.

Where the symblepharon is so extensive that it is impossible to obtain from the conjunctival sac sufficient mucous membrane to cover the defect left by its removal, it obviously becomes necessary to secure a substitute for the conjunctiva from some outside source. For this purpose there have been utilized *mucous grafts* taken from the fellow eye or from that of a donor, from eyes of rabbits, dogs and sheep, also from the vagina and prepuce; *cutaneous grafts* after the methods of Wolfe and Thiersch, and pedunculated skin-flaps turned in from neighboring parts of the face.

Each of these tissues has its own field of usefulness in meeting special indications. The better the state of preservation of the eye, particularly as regards the cornea, the more essential it is that it should be surrounded by conditions and tissues as nearly normal as possible. In such cases mucous grafts undoubtedly afford the most suitable material as they are well tolerated by the cornea and do not suffer maceration from the tears as do tissues whose habitat is free from moisture. Skin-grafts are always more or less irritating to the sensitive cornea, either from dryness, oiliness, from the fine hairs they contain, or from the dead epithelium that accumulates on the surface. For, while the character of a skin-graft implanted in the conjunctival sac becomes in time somewhat modified, on account of its new surroundings, it cannot assume the nature of mucous membrane, but still remains dermic and exfoliates thick masses of dead epithelium

which require frequent mechanical removal to prevent irritation. The ease with which mucous grafts can be secured, either from man or the lower animals, and their usual survival of transplantation seem to add to their adaptability and furnish grounds for a good prognosis. As a matter of fact, however, the ultimate results of their employment have been almost uniformly disappointing. The immediate result is usually satisfactory, but there almost invariably follows an insidious shallowing of the cul-de-sac until, at the end of a few months, the good effect of the operation is entirely nullified. Against this gradual pushing up of the fornix no known force is of much avail; artificial eyes, plates of glass or metal and all other measures have been equally unsatisfactory.

The first recorded attempt to substitute the conjunctiva of the lower animals for that of man was made by Wolfe, of Glasgow, in 1872, who used rabbits' conjunctiva. In 1873 Stellwag tried not only rabbits' conjunctiva but the mucous membrane from the mouth and vagina. Attributing their failures to the extreme frailty of the membrane, Panas tried the conjunctiva of a dog, but fared no better.

In transplanting mucous grafts from the conjunctiva of the lower animals, the technique usually practised is as follows: The patient's eye having been cleansed in the usual way the symblepharon is completely detached, the field of operation flooded with warm normal salt solution, and bleeding stopped, by pressure if necessary. The animal chosen having been chloroformed, its eye is held open by means of sutures run through the lids, and the conjunctiva cleansed by copious irrigation of boric acid and, finally, normal salt solution. Two or more sutures are now inserted in the conjunctiva at the borders of the area to be excised, to facilitate handling it and to aid in identifying the epithelial surface after the piece has been removed. If this is not done it is almost impossible to tell front from back. The graft is dissected from the globe and transferred directly to its new bed if it is ready to receive it; otherwise it is dipped into the warm salt solution while the patient's lid is everted and strongly drawn away from the globe, which is rotated in the opposite direction so as to expose the bottom of the cul-de-sac. The graft is now adjusted by means of the sutures referred to, care being taken to have it right side out and sutured to the borders of the healthy tissue. In order to draw the graft well down into the fornix, loops of thread may be passed over it at this point, run diagonally downward through the lid and tied over a cylinder of gauze on the skin of the cheek. Some operators allow these threads to remain until they cut through, while others lay a piece of sterile oil silk along the fornix before inserting the stitches (to prevent their cutting through) and remove them in about a week.

A more modern method utilizes a plate of sheet lead cut to fit the fornix. This is protected by a coating of paraffin which is inserted in the cul-de-sac to hold the graft down in the fornix. The plate may be of the half-moon type, secured by sutures; or the oval plate, whose shape and size hold it in position. These plates are described in greater detail in subsequent pages.

In some cases of extensive symblepharon pedunculated skin flaps have proven more satisfactory than mucous grafts, yet their results leave much to be desired. Their resistance to ultimate effacement from gradual contraction of the fornix is somewhat greater than is the case with the more delicate mucous grafts on account of their better nutrition and greater thickness, but this apparent advantage is offset by the disadvantage of transplanting dermic tissue into an environment suitable only for mucous membrane—a condition whose evils have previously been dwelt upon.

One of the first surgeons to attempt this method of dealing with extensive symblepharon was Taylor, who in 1876 reported an operation in which he took a flap from the lower lid and introduced it into the cul-de-sac through a buttonhole cut through the fornix near the pedicle of the flap; twisting it 180° on its long axis to bring the raw surface in contact with the defect on the inside of the lid. Here it was stitched into position with its epidermal surface next the globe. The outer defect was closed with sutures.

Harlan's Operation for Symblepharon.

Another variation of the flap and buttonhole operation, practised by Harlan, is performed as follows: A bridge flap (with relatively narrow pedicles at each end) is designed on the cheek below the lid by two horizontal incisions, the upper one of which is cut through into the bottom of the newly prepared fornix. Through this slit the flap is pushed and twisted on its pedicles so as to bring the raw surface in contact with the inside of the lid. The secondary defect is closed by sutures or grafting, according to its size.

It is to be inferred from reading the descriptions of most of these measures that the transplanted flap is used only to line, or cover, the *palpebral* part of the defect, and that the *ocular*, or *bulbar* portion is left to care for itself as best it can. This method, of course, is not good surgery. The transposed tissue should be of dimensions sufficient to cover the entire raw area, *i. e.*, either one flap broad enough to fold upon itself so as to lie in contact with both globe and lid, or two flaps, one for the globe, the other for the lid. If the folded flap is used, loops of thread are put into the fold, and if two flaps, the edges that lie in the cul-de-sac, constituting the new fornix, are

stitched to the tarso-orbital fascia at the rim of the orbit by sutures that pass outward through the lid and are tied over rolls of gauze.

The Panas Operation for Symblepharon.

Panas covered both the bulbar and palpebral wounds with skin flaps, taking one from the temple and the other from the cheek, introducing them through a buttonhole in the outer orbito-palpebral furrow and applying them to the globe and lid respectively. After they had become firmly adherent the pedicles were cut and the cheek wound closed. For total symblepharon of both lids he took from the temple a large flap the shape of a tennis racquet and turned it in through the palpebral fissure so as to bring its raw surface in contact with the inside of the two lids, which were stitched together. At the end of three months the flap was bisected along the lid edges and the palpebral fissure re-established. This operation was a failure, perhaps to a large extent, because there was no attempt made to cover the defect in the ocular conjunctiva, or to anchor the cul-de-sac for the purpose of counteracting the effects of shrinkage. The only opera-

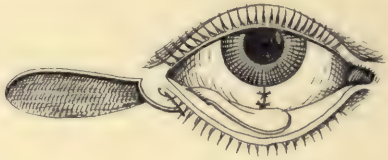


Fig. 779.
Snellen's Blepharoplasty for the Relief of Symblepharon.

tions of this class which have enjoyed any considerable degree of success have been those in which a capacious cul-de-sac has been provided, both sides of it protected by grafts and means provided for preserving it and protecting it from shrinkage. Aside from anchoring down the fornix by means of skin flaps passed through a buttonhole in the cheek the most successful supports, both to retain the shape and depth of the cul-de-sac and hold the graft in position, are the glass and porcelain eye shields and the paraffin covered lead plates cut to size and moulded to fit over the globe.

Samelsohn is the originator of a successful but formidable operation in which he cuts a quadrilateral flap from one lid, leaving its edge attached along the ciliary border, and turns it into the opposite cul-de-sac to line the inside of that lid. When union has become firmly established the flap is severed at its base and the same thing repeated for the other lid, if necessary. This procedure leaves a lid with engrafted tissue on both sides, because the secondary defect must of course be covered to avoid producing a bad scar in a place where

contraction is liable to cause serious deformity. Under such conditions it seems that it would be almost impossible for the lid to retain its natural shape.

THIERSCH GRAFTS IN EXTENSIVE OR TOTAL SYMBLEPHARON.

Epidermic, or Thiersch, grafts afford the best known means of repairing extensive posterior or total symblepharon if the globe is present and to be preserved, as also for the restoration of the cul-de-sacs in anophthalmos. Small bits of skin were used to a limited extent in replacing conjunctival tissue by von Arlt, who applied them after the manner of Reverdin, upon a granulating surface. Later, Eversbusch and others adopted the use of larger pieces of skin, the Thiersch grafts, which were much more satisfactory, and enjoy the greatest popularity today. There has never been serious difficulty in getting the graft to live, but to preserve the cul-de-sac from obliteration by shrinking has been a well nigh hopeless task until within the last few years. In order to accomplish this surgeons have gone to every extreme, the work of Continental surgeons having been especially heroic. These have, for the most part, taken some form of making a temporary flap of the lid, restoring it to position after healing was complete.

Czermak's Operation in Extensive Symblepharon.

This procedure is a fair example of the class just mentioned and is performed as follows: A free canthotomy is done and from the end of this cut an incision is made which includes the entire thickness of the lid, down along the orbito-palpebral furrow to a point below the inner canthus. This flap is dissected from its adhesions to the globe and turned back over the nose. The raw surface on the globe is now covered with the Thiersch graft and protected by a layer of gutta percha tissue smeared with vaseline. The denuded surface of the flap is likewise covered and the lid turned back into place. The gutta percha, extending beyond the borders of the wound in all directions, insures the avoidance of adhesions and a consequent epidermization clear to the bottom of the cul-de-sac. When the new skin has become firmly united the edges of the flap and adjacent side of the cheek are freshened and the lid sutured into position. This operation is claimed to provide a deep and enduring cul-de-sac and to be especially useful in providing a socket for a prothesis.

These mutilating operations have seldom been resorted to in the United States, but a gratifying degree of success has been attained by using the same form of graft in a more conservative way.

The Hotz Operation for the Restoration of the Cul-de-Sacs.

Hotz, of Chicago, and May, of New York, were pioneers in this branch of surgery in this country, and their first successful work was reported about 1897. Since that time there has been little change in either methods or results. With slight variation of technique, but without change of principle, these operations are performed as follows: The lid is thoroughly dissected free from its attachment to the globe and the cul-de-sac is made large in all dimensions, all cicatricial bands being severed. The plate which is to hold the graft in place is now fitted. This plate is the keystone of the operation. It may be made of porcelain (May), sheet lead (Hotz), block tin (Woodruff), hard rubber (Weeks), celluloid (Haitz), or of some soft metal covered with paraffin (Wilder), but it should always be large enough to entirely fill the new socket. After the size and the shape of the plate have been satisfactorily arranged, the graft is taken from the inner side of the arm and transferred directly to the plate, where it is folded over the edges with the raw surfaces out. The plate and graft are then placed in the newly prepared socket and the lids closed over them and held in that position either by sutures or strips of adhesive, over which is put the usual dressing and bandages. It is essential to keep the lids as quiet as possible and to this end both eyes are kept bandaged until the grafts have become firmly adherent, which requires from 4 to 6 days. At the end of that time the plate is removed but the eye is kept bandaged for a few days longer. It is well to cut an opening in the center of the plate for purposes of observation and cleansing. When the globe is present this opening should correspond in size to that of the cornea, thus obviating pressure of the metal upon it and permitting its condition to be seen. When the globe is absent some operators make two holes, about 5 mm. in diameter and 15 mm. apart, to furnish drainage and means of irrigation before the plate is removed. The author has found that a single opening answers all these purposes, and is preferable in extensive restoration because it does not occupy space needed for the grafts.

Weeks' Operation for Cicatricial Orbit.

Weeks, in 1904, reported an elaboration of the ordinary plate method of grafting, whose good results he attributes to the fact that the graft is attached to the periosteum at the rim of the orbit.

The case then reported was one of anophthalmos with obliteration of the socket. A free canthotomy was made and the lid detached almost to the rim of the orbit. Into this new cul-de-sac was placed a large Wolfe graft folded upon itself so that the raw surface covered the wounds on the stump and lid. Sutures passed through the bottom of this crease were also put through the periosteum of the orbital rim

and out on the cheek. This draws the graft down into the bottom of the fornix where it is further maintained by means of the plate which is inserted after the edges of the graft have been sutured to the stump and conjunctiva of the lid. The last step is the closure of the canthotomy. The deep sutures are left in for fourteen days, those of the conjunctiva and stump one week. The plate is left in position until all shrinkage of the flap ceases.

There seem to be many advantages gained by using the plate and no dangers. For it is claimed that (1) it enables one to accurately place the graft in position; (2) it holds it in position at the very bottom of the cul-de-sac; (3) it secures accurate and firm approximation of the whole extent of the graft; (4) it secures a greater degree of immobility and rest for the parts during the process of repair than any other method.

In addition to these merits, common to all plates, the following are claimed for that of metal coated with paraffin. It possesses greater smoothness and is less irritating to the cornea, may be easily built up to appropriate form and thickness and furnishes a bed upon which the graft is more easily spread out than upon naked metal, rubber or porcelain, and is unaffected by the secretions of the eye. Large metal plates may be cut in two to facilitate removal. Wilder, the originator of the paraffin-coated plates, advises the use of paraffin of a melting point not lower than 130° F.

When the restoration is extensive, as in obliteration of the socket with anophthalmos, in view of the inevitable shrinkage of the newly formed cavities, it is important that the fashioning of the cul-de-sacs and of the paraffined plate, be done on a large scale. To this end it is essential to make provisional canthotomy the first step. This act serves two purposes, (1) it opens up the field of operation and (2) it permits the insertion of a much larger plate than could otherwise be employed. When the time comes to remove the plate either the canthus is again divided and subsequently resutured or else the plate is cut in two by means of strong, blunt-ended scissors.

CHAPTER XIV.

OPERATIONS FOR THE RELIEF OF TRICHIASIS, ENTROPION, PTOSIS AND EPICANTHUS—REMOVAL OF TUMORS OF THE EYELIDS.

By WM. H. WILDER, M. D., Chicago, Ill.

Surgical Anatomy of the Eyelids—Muscles of the Eyelids—The Tarsi—Borders of the Lids—Orbital Septum—Trichiasis—Distichiasis—Entropian—Correction of Spastic Conditions of the Fibers of the Orbicularis—Gaillard-Arlt Suture—Snellen's Suture for Entropion—Correction of Spastic Entropion by Cicatricial Contraction of the Skin After Cauterization—Correction of Entropion by Excision of Skin Near the Border of the Lid—Graefe's Operation for Entropion Spasticum—Entropion Operation of Panas—Correction of Entropion by Excision of a Bundle of Muscle Fibers Near the Lid Border—Correction of Entropion by Section of the Fibers of the Orbicularis at the Lateral Raphé—Correction of Faulty Positions of the Cilia—Removal of the Cilia in Trichiasis—Electrolytic Epilation—Complete Removal of the Cilia Border in Trichiasis—Flarer's Operation—Flarer-Stellwag Operation for Trichiasis—Operation of Jaesche-Arlt—Landolt's Operation for the Relief of Trichiasis—Operation of Spencer Watson for Complete Trichiasis—Operation of Spencer Watson for Partial Trichiasis—Treatment of the Free Border of the Lid by Implantation of Flaps of Mucous Membrane—Van Millingen's Operation for Entropion—Entropion Operation of Mutermilch—Correction of Incurving of the Tarsus by Tension Sutures—The Hotz Operation for Entropion and Trichiasis—Correction of Distortion and Incurving of the Tarsus by Section or Partial Excision of it, or a Combination of this with Sutures—Tarsoplasty—Entropion Operation of Burow—Operation of Green for Entropion—Entropion Operation of Williams—Operation of Lagleyze—Section or Partial Excision of the Tarsus from the Anterior Surface—Streatfeild's Operation for Entropion—Snellen's Operation for Entropion—Entropion Operation of Panas—Combination Operations for Entropion—Beard's Operation for Entropion—Wilder's Combined Operation for Marked and Neglected Forms of Entropion—Ptosis—Acquired Ptosis—Pseudo-Ptosis—Treatment—Hunt's Operation—Operation of Dransart—Operation of Pagenstecher—Mules' Operations for Ptosis—Worth's Operation—Harman's Operation—de Wecker's Operation—Operation of Hess—Landolt's Operation for

PLATE XIII

Vertical Section through the Upper Eyelid, showing also the Course of the Vessels and Nerves. (After Merkel and Kallius.)

Ptosis— Operation of Panas—Allport's Modifications of Panas' Operation —Grimsdale's Modifications of Panas' Operation—Tansley's Operation for Ptosis—Operation of Rollet for Ptosis—Operation of Darier—Operation of Fergus—Operation of Angelucci—Operation of Sourdille—Bowman's Operation for Ptosis—Operation of Eversbusch—Snellen's Operation— Wolff's Operation for Ptosis—Operation of Lapersonne—Elschnig's Operation for Ptosis—Operation of Gillet de Grandmont—Beard's Operation for Ptosis—Wilder's Operation for Ptosis—Operation of Motais— Parinaud's Operation—Summary—Epicanthus—von Ammon's Operation —Operation of Berger for Epicanthus—Operation of Wicherkiewicz— Operation of Rogman—Foggin's Operation—Hordeolum—Chalazion— Agnew's Operation for Chalazion—Conjunctival Method—Cutaneous Method—Meibomian Infarcts—Tumors of the Lids—Operations on Lid Angioma—Angiofibroma—Lymphangioma.

SURGICAL ANATOMY OF THE EYELIDS.

The eyelids* (*palpebræ*) arise as folds of the outer skin, designed for the protection of the eyeball. Their free borders form the palpebral fissure, the ends of which are known as the external and internal canthi. The external canthus (*angulus oculi lateralis*) forms an acute angle, while the internal canthus (*angulus oculi medialis*) is a rounded notch surrounding the lachrymal lake (*lacus lachrymalis*). When the lids are open there is seen in this notch the caruncle (*caruncula lachrymalis*) a small olive-shaped elevation of the conjunctiva, in which may be seen fine hairs.

The lachrymal lake reaches laterally as far as the *papilla lachrymalis,* a small elevation on each lid border, in the apex of which is the *punctum lachrymale,* the opening into the canaliculi.

The *palpebral fissure* varies in its dimensions in health. According to Luschka and Sömmering its length is 3 cm. and its width 1.5 cm., but often the width does not exceed 10 or 12 mm. The dimensions are usually smaller in women than in men, but in children the palpebral opening is nearly equal to that of the adult. Its size influences greatly the expression of the eye, which seems large and full or small, according as this fissure is wide or narrow. In certain races, notably the Esquimaux, Laplanders and other northern peoples, the palpebral opening is much smaller than in those living in the temperate and tropical zones. In the Mongolians there is an apparent obliquity of the palpebral fissure which gives these people a characteristic expression. This, however, is more apparent than real, and is caused by a fold of skin that stretches over the inner angle of the eye similar to the more exaggerated pathologic condition of epicanthus.

---

*For a further account of the anatomy of the lids, including a description of their vascular and nervous supply and their relations to a number of palpebral operations, see Beard's Chapter on Blepharoplasty.

In health the palpebral opening is usually of such dimensions that the margin of the upper lid covers the upper third of the cornea, while that of the lower lid strikes the inferior margin of the cornea.

The *upper eyelid* is bounded above by the eyebrow (supercilium), which is more or less thickly covered with hairs that are mostly directed temporalwards. They are more numerous and stronger over the median angle of the eye and disappear in the neighborhood of the

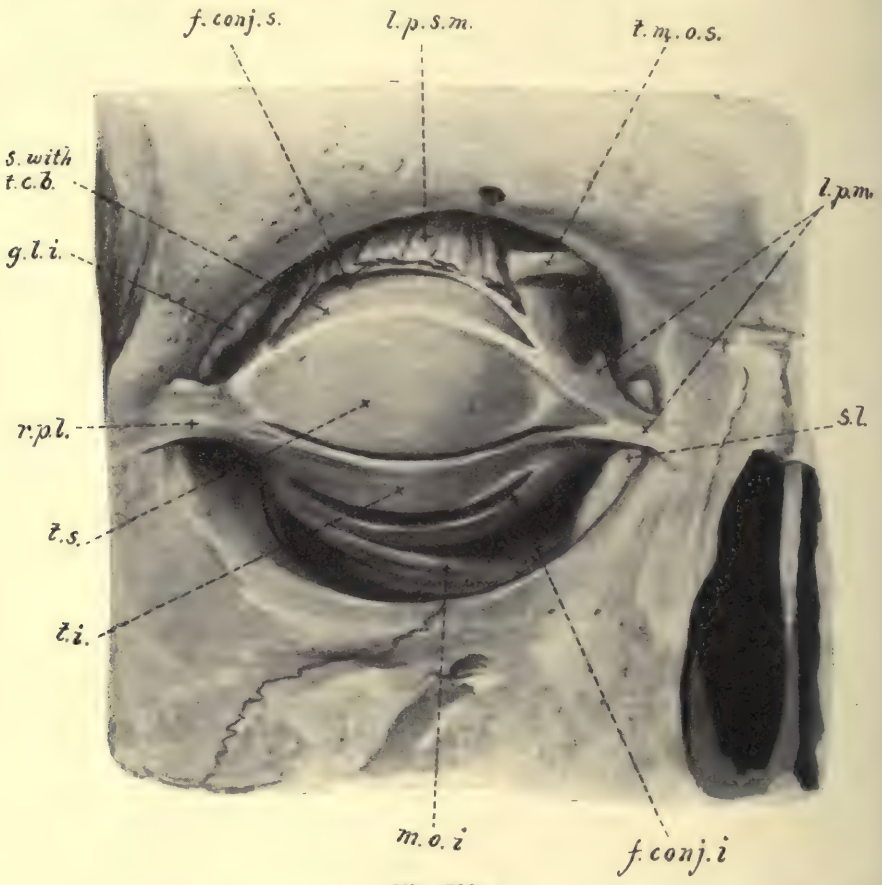


Fig. 780.

Lid Plates of the Right Eye Dissected out. Viewed from in Front. (After Spalteholz.)

The insertion of the m. levator palpebræ superior. has been removed, and the conjunctival sac has been opened from in front, above and below the lid plates.

s. with t.c.b., sclera with tunica conjunctivæ; *g.l.i*, glandula lachrymalis inferior; *r.p.l.*, raphe palpebralis lateralis; *t.s.*, tarsus superior; *t.i.*, tarsus inferior; *f.conj.s.*, fornix conjunctivæ superior.; *l.p.s.m.*, levator palpebræ superior.; *t.m.o.s*, tendo m. obliqui superior.; *l.p.m.*, ligament. palpebræ median.; *s.l.*, saccus lachrymalis; *m.o.i.*, m. obliqus inferior.; *f. conj.i.*, fornix conjunctivæ inferior.

sutura zygomatico-facialis. In certain cases the hairs are entirely wanting. The skin of the brow is somewhat thickened, and into it are inserted bundles of muscle fibers from the orbicular and frontal muscles. The eyebrow moves rather readily over the orbital margin, to the periosteum of which it is attached by loose cellular tissue.

There is no such sharp boundary line between the skin of the lower lid and the cheek.

The *skin of the lids* is very thin, provided with very fine downy hairs, and easily movable and thrown into wrinkles. It is because of this lax condition that edema and ecchymoses occur so readily in this neighborhood after injuries of, or operations on, the lids.

However, at the free margin of the lids the skin is very firmly attached to the subjacent tarsus by rigid connective tissue. Fibers from the *levator palpebræ* run to that part of the skin of the lid that lies over the convex border of the tarsus (see Fig. 780), so that when the lid is raised the skin is drawn in between the tarsus and the margin of the orbit, forming a furrow or sulcus *(sulcus orbito-palpebralis superior and inferior).* The lax skin extends in a fold over this furrow, and in certain cases this fold may hang over the free border of the lid, constituting the condition known as *ptosis adiposa.*

Beneath the skin of the lids, as mentioned above, is a layer of loose, distensible connective tissue, further characterized by complete absence of fat.

Muscles of the Eyelids.

Beneath the layer of loose cellular tissue may be seen the fibers of the *orbicularis palpebrarum,* which encircles the palpebral fissure, acting as a sphincter in closing the lids. (Fig. 781.) This is a flat, thin, cutaneous, muscle layer, whose fibers, especially those running near the lid margins, are very pale. In extent, it overlaps the bony margins of the orbit, especially laterally, and the most peripheral bundles blend with adjacent muscles of the face, or lose themselves in the skin.

Although there is no distinct anatomical division, this muscle may be considered as having three parts, the palpebral *(pars palpebralis),* orbital *(pars orbitalis)* and lachrymal *(pars lachrymalis* or *musculus Horneri).* The fibers of the palpebral portion arise from the internal palpebral ligament *(ligamentum palpebrale mediale)* and pass in curved bundles over each lid, to be inserted into the external canthal ligament *(raphé palpebralis lateralis).* Many of the fibers are inserted into the skin.

The bundles of the orbital portion, which lie on the orbital margin and the parts surrounding it, are more curved than those of the palpebral portion. They cover the attachment of the musculus frontalis, with the bundles of which they are in intimate relation.

The lachrymal portion (muscle of Horner) is a deeper layer having its origin from the posterior limb of the *ligamentum palpebrale mediale* and from the *crista lachrymalis posterior* and a part of the lachrymal bone behind the posterior crest. (See the figure.) Passing forward in two fan-shaped layers the fibers are inserted into the free border of the lid, some of them surrounding the canaliculi.

The internal palpebral ligament *(ligamentum palpebrale mediale)* is a bow-shaped tendon which surrounds a triangular space in which rests the lachrymal sac. The anterior limb of this ligament, about 3 to 4

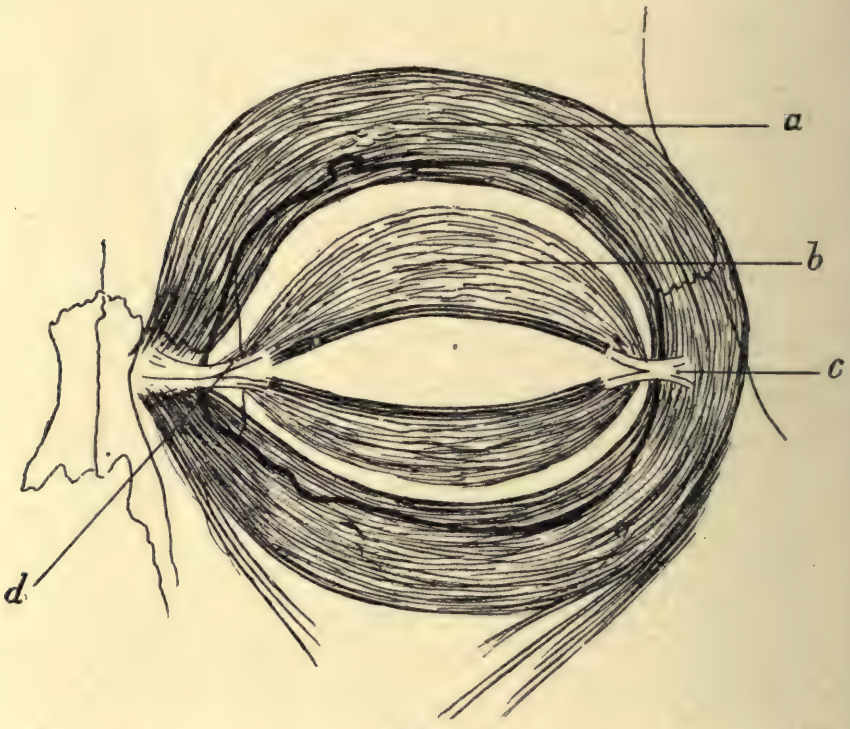


Fig. 781

Musculus Orbicularis Palpebrarum. *a*, **orbital portion;** *b*, **palpebral portion;** *c*, **raphe palpebralis lateralis;** *d*. **ligamentum palpebrale med.** ***The heavy black line indicates the margins of the orbit.*** **(After Charpy.)**

mm. broad, arises from the frontal process of the superior maxilla, passes outward and then backward around the upper end of the lachrymal sac to be attached again to the *crista lachrymalis posterior*. This latter portion is known as the posterior limb of the ligament, and has usually twice the breadth of the anterior.

Fibers of connective issue pass from the anterior limb to the skin and this portion of the ligament can be easily seen at the inner angle

of the eye as a tense band, especially in thin persons or if the lid margins are put upon the stretch by separating and drawing them toward the temple. It forms an important landmark for operations on the lachrymal sac, the upper end of which lies directly behind it.

The external palpebral ligament *(raphé palpebralis lateralis)* is not like the medial ligament, a well-defined band, but is a tendinous inser-

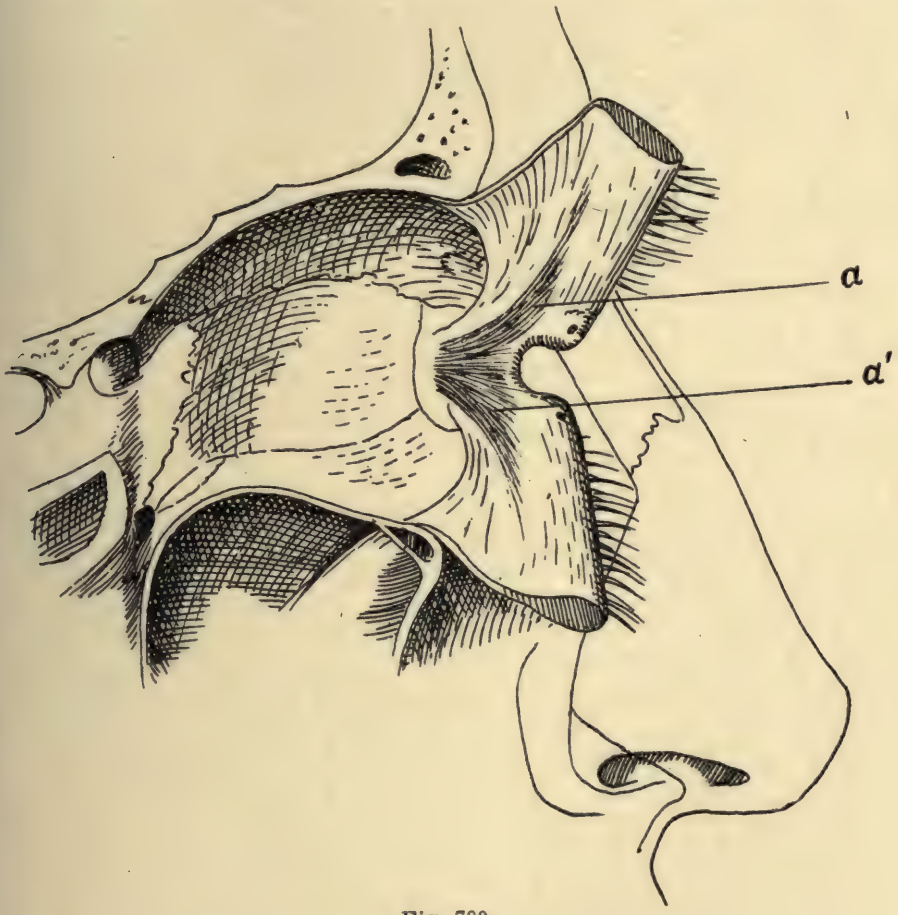


Fig. 782.
Muscle of Horner, *a*, *a*.[1] (After Poirier and Charpy.)

tion of firm connective tissue, connecting the lateral ends of the tarsal plates with the temporal margin of the orbit, its fibers often attaching themselves to the wall of the orbit, immediately behind the margin. (Figs. 781 and 782.)

The *levator palpebræ superioris* arises from the upper part of the tendinous ring surrounding the optic canal at the apex of the orbit and

runs forward as a flat muscle beneath the roof of the orbit. It covers the rectus superior, with which it is connected by fascial bands, and is inserted by a broad, fan-shaped attachment to the whole upper border of the tarsus, with whose fibers those of the muscle tendon mingles.

In action, it draws the lid upward and backward over the curve of the eyeball, similar to the action of the cover of a roll-top desk. Some of its fibers, passing between the bundles of the orbicularis, are inserted into the skin of the lid, so that when this is drawn upward and backward there is formed the furrow known as the *sulcus orbito-palpebralis.*

The levator palpebræ is a striated muscle, but on its under surface, not far from its insertion, is a small, unstriated muscle bundle known as the muscle of Müller *(musculus tarsalis superior).* Its fibers arise between the bundles of the levator and pass to the upper convex margin of the tarsus, where they are attached, sometimes by an elastic, tendinous band. Its length is about 10 mm. and its size is variable.

A similar muscle *(m. tarsalis inferior)* exists in the lower lid, where it arises beneath the fornix of the conjunctiva and is inserted into the lower margin of the inferior tarsus.

The lower lid sinks by its own weight sufficiently to expose the lower part of the cornea.

The orbicularis oculi is innervated by the seventh nerve, the tarsalis superior and tarsalis inferior by the sympathetic.

The Tarsi.

The tarsi (superior and inferior), or lid plates (Figs. 780 and 783), are firm, tough, connective tissue discs, intimately connected with the surrounding tissues and especially so with the conjunctiva, from which they can with difficulty be dissected. They are shaped like a myrtle leaf; their anterior surfaces, to which the orbicularis is attached by rather firm connective tissue, are convex, while their posterior surfaces are concave, conforming to the shape of the eyeball. The borders of insertion are convex while the free margins are almost straight. They are about 20 mm. in length, and in thickness from 0.8 mm. to 1 mm. The superior tarsus at its widest point is about 10 mm., while the inferior at a corresponding point is only about half as wide. They are continuous at their medial angle with the *ligamentum palpebrale mediale,* and at their temporal with the *raphé palpebralis lateralis.*

In the substance of the tarsi are found the Meibomian glands *(glandulæ tarsales),* 30 to 40 in the superior and 20 to 30 in the inferior tarsus, running through the whole height of the lid plate; so that the glands are longest at the middle and shortest at the angles of the tarsi. They are elongated, acinous glands, secreting a fatty substance *(sebum*

palpebrale), which escapes from the tiny ducts that open on the free border of the lid behind the row of cilia.

Borders of the Lids.

The free border of the lids bounds the palpebral fissure. At this point the lids are about 3 mm. in thickness, and the skin is more firmly attached to the tarsus than to the rest of the eyelid. When the lids are closed the narrow surfaces which form the borders come into perfect coaptation, thus completely closing the conjunctival sac. The anterior margin of the free border is rounded and has projecting from it the cilia, which are arranged in several rows, the roots of which dip into the skin to a depth of about 2.5 mm. Sometimes they are planted more thickly on the cutaneous surface; in other cases they are more abundant on the border of the lid. They are more numerous and larger on the upper lid than on the lower, and grow more abundantly in the center than toward the angles of the lids. Emptying into the follicles of the cilia are small sebaceous glands *(glands of Zeiss)*; also, small tubular glands, modified sweat glands *(glands of Moll.* See Plate XIII).

The posterior margin of the free border is rather sharp, the conjunctival surface and the surface of the free border forming here almost a right angle. Sometimes this posterior margin is more or less rounded off, and this is noticeably so in certain diseased conditions of the lids, such as trichiasis and cicatricial entropion.

Just anterior to the posterior margin may be seen the minute openings of the Meibomian glands, and between that and the row of cilia is a fine grayish line that marks the division of the lid into its anterior, or cutaneous, portion and its posterior, or conjunctival, portion. The former contains the orbicularis fibers, the skin and cilia; the latter the tarsus and conjunctiva. The grayish line furnishes a landmark for certain operations on the lid border, such as those for trichiasis, entropion, chalazion and intermarginal grafting.

Orbital Septum. Septum Orbitale.

Stretching from the orbital margin to the tarsal plates, and blending with the palpebral ligaments, is a fascial structure of considerable surgical importance, known as the *septum orbitale.* (See Figs. 780 and 783.) When the lids are closed this layer of fascia, together with the tarsi and canthal ligaments, forms a firm diaphragm that holds back the contents of the orbit. Below, it is attached to the margin of the orbit; on the temporal side, a little behind the real margin, uniting with the *raphé palpebralis lateralis;* above, with the superior margin of the orbit. On the nasal side, where the orbit lacks a distinct margin, it is attached to the rough bone immediately in front of the trochlea and along a line that includes the *crista lachrymalis posterior* to the inferior

margin of the orbit. Hence it lies in front of the pulley of the superior oblique muscle and behind the lachrymal sac, but it connects with the posterior limb of the *ligamentum palpebrale mediale*.

In the superior medial portion, near the margin of the orbit, are three openings in the fascia; one for the supraorbital vessels and nerve, one for the frontal vessels and nerve, and the third for that branch

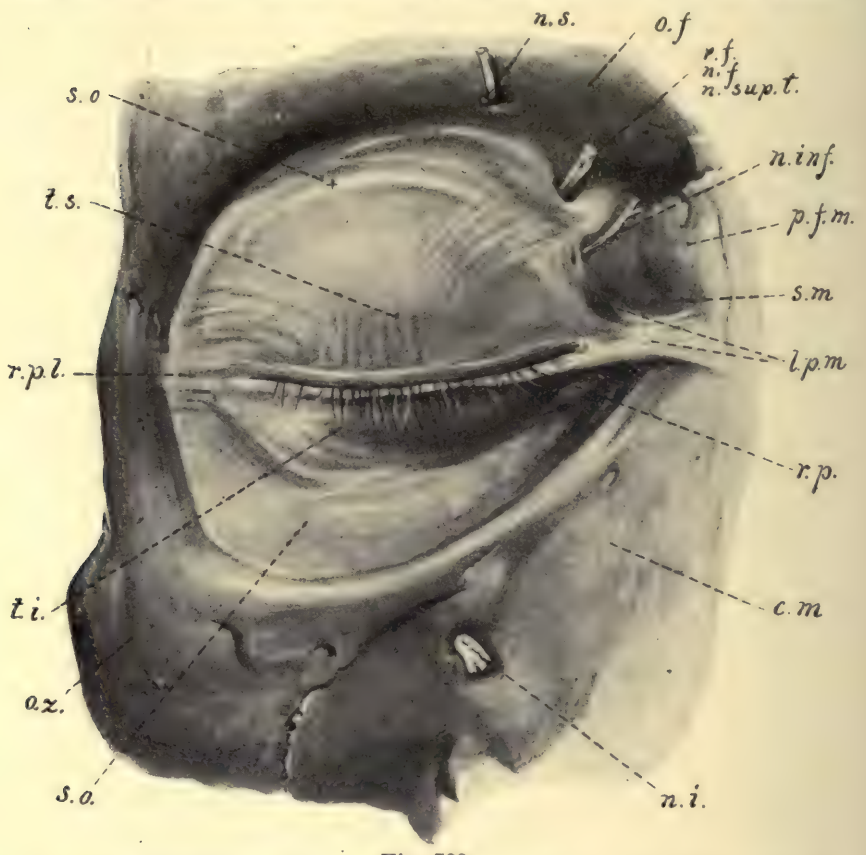


Fig. 783.

Septum Orbitale, Viewed from in Front. The m. orbicularis oculi has been dissected off. (After Spalteholz.)

s.o., septum orbitale; *t.s.*, tarsus superior; r.p.l., raphé palpebralis lateralis; *t.i.*, tarsus inferior; *o.z.*, os zygomaticum; *n.s.*, n. supraorbitalis; *o.f.*, os frontale; *r.f.*, *n. f.*, n. frontalis; *n. sup. t.*, n. supratrochlearis; *n. inf.*, n. infratrochlear.; *p.f.m*, proc. frontalis; *s.m.*, saccus lachrymalis; *l.p.m.*, ligament. palpebral, median.; *r.p.*, rima palpebrarum; *c.m.*, corpus maxillæ; *n.i.*, n. infraorbitalis.

of the superior ophthalmic vein that anastomoses with the angular vein. From its bony attachments this fascia stretches to the convex borders of the tarsal plates to which it is firmly attached; it is also closely connected with the canthal ligaments, as before mentioned.

In addition, the fascial coverings of the levator palpebræ superioris, the rectus superior and the rectus inferior have a firm connection with the septum orbitale, so that the action of these muscles upon the lids and the eyeball is limited by this structure. The septum is thinner in its lower and medial portions than at the upper, where it is reinforced by the tendinous fibers of the levator palpebræ superioris.

The position of these fascial layers has an important influence on the direction of growths, effusions or exudates in the orbit, and their effect upon the eyelids.

TRICHIASIS, DISTICHIASIS AND ENTROPION.

Trichiasis.

This is a condition of the lid in which some or all of the cilia are distorted, displaced and turned inward toward the eyeball. Normally, the cilia are arranged in several rows on the anterior margin of the free border of the lid, those of the upper lid curving forward and upward, those of the lower lid projecting forward and downward. With partial closure of the eyelids there is a certain amount of interlacing of the eyelashes that furnishes a degree of protection to the eyeball from dust and wind.

In the milder forms of trichiasis, the posterior row of the cilia is turned backward, so that some or all of the hairs may come into contact with the eyeball. In the severer forms of the disease the anterior rows may also be directed downward or even backward, so that all of the lashes may rest against the eyeball. The cilia are usually changed in appearance, are stunted and stubby, and may grow straight out from the free border of the lid. Some of them may be so fine as to be scarcely visible to the unaided eye.

These changes are brought about by diseases or injuries that affect the border of the lid or the conjunctiva, and so alter the nature and direction of the hair follicles. Consequently we frequently see this condition after trachoma, blepharitis, burns of the edge of the lids and diphtheria; while the partial forms are noticed after hordeolum, chalazion and abscesses of the lids.

Trichiasis, aside from the disfigurement and discomfort that it produces, may be exceedingly serious, for the rubbing of the eyelashes against the cornea may occasion pannus, as well as opacities or ulceration of that structure.

DISTICHIASIS.

Distichiasis is the term used for the condition in which there is a double row of eye lashes, the anterior of which may be directed normally, while the posterior is directed downward and backward from

the free border of the upper lid. Naturally this is only a variety or degree of trichiasis, if it is acquired, and inasmuch as there is a congenital condition in which the cilia grow in two rows as described, the term districhiasis should be reserved for it.

ENTROPION.

Entropion is an *exaggerated degree of trichiasis* with this difference, that whereas in trichiasis the free border of the lids remains in its normal position, in entropion the free border is turned inward toward the eyeball. There are two varieties, *entropion spasticum* and *entropion cicatriciale.*

Entropion Spasticum. Normally the plane of the free border of the upper lid faces downward, that of the lower lid upward. The posterior margin is sharp, almost a right angle. Any cause that operates to change the curvature of the lid plates, so as to force the free border inward, will bring about entropion. One such cause is *spasm of the orbicularis,* particularly of those bundles that lie near the palpebral fissure. This gives rise to the form known as *spastic entropion.*

The bundle of orbicularis fibers surrounding the palpebral fissure presents a curve whose concavity is directed toward this fissure. Furthermore, by reason of its position over the surface of the eyeball, this bundle has a curvature whose concavity is backward. In forcible contraction of this bundle, as in spasm, it is plain that the edge of the lid, to which the muscle is so firmly attached, tends to assume the position of the chord of the arc of these curvatures and as a result is turned inward. This occurs more readily if the edge of the lid has lost the support of the eyeball; hence spastic entropion is frequently seen after enucleation, if the patient does not wear an artificial eye.

Again, if the tissues of the lids are much relaxed, the skin very distensible, and the contents of the orbit shrunken, the conditions are favorable for spastic entropion. Hence, we see it more frequently in old people and particularly in the lower lid, the tarsal plate of which gives it less firmness than that of the upper lid. Because of the firmness of the tarsal plate in that organ spastic entropion rarely affects the upper lid.

The disease is observed in the blepharo-spasm of children, in blepharophimosis, and is frequently caused by long-continued, firm bandaging of the eyes of elderly persons whose skin is flabby, as after cataract operations.

Entropion cicatriciale. The cicatricial form of entropion is the result of distortion of the tarsal plate by the contraction of cicatricial tissue that has formed in it and in the conjunctiva covering it. Such

cicatrization is usually the result of long continued trachoma; or it may follow burns, pemphigus or diphtheria of the eyelids or conjunctiva.

The contraction of the scar tissue "buckles" the tarsus so that its under surface is much more concave than normal, and in chronic cases of trachoma presents a distinct furrow parallel to the free border. Corresponding to this furrow there may be on the anterior surface of the tarsus a distinct ridge. Because of the bowing inwards of the tarsus the posterior margin of the free border is pressed against the cornea and by constant attrition is rounded or beveled. As a result of the continued irritation of the cornea by the border of the lids, and it may be by the cilia, a certain degree of blepharospasm is excited which aggravates the trouble by adding the spastic to the cicatricial form. In the severest forms the lid may be so incurved that the lashes rest on the eyeball, as they do in typical cases of trichiasis or spastic entropion.

It will be seen that in trichiasis there is no distortion of the lid plate, except possibly around the hair follicles on the free border and, therefore, no real entropion, while in cicatricial entropion there may be trichiasis in addition to the deformity of the tarsus. In deciding upon the operative treatment of trichiasis and entropion, these various features should be borne in mind, and the operation must be varied to suit the individual case. If the spastic feature predominates, this must receive especial attention, while if trichiasis is the marked feature, without the more severe cicatricial entropion, certain other operations will be applicable.

Inasmuch, therefore, as trichiasis and entropion so frequently coexist, and as the latter is to be regarded as an exaggerated variety of the former, it is expedient to consider their operative treatment together.

The following principles should be carefully considered in the *treatment* of these conditions, which for convenience may be arranged in synoptic form.

Class I. Correction of Spastic Conditions of the Fibers of the Orbicularis.

Group a, by removal of pressure on the lids by dressings, bandages, etc.; group b, by temporary tension on the skin by collodion or adhesive strips, or by sutures, such as those of Snellen, etc.; group c, by cicatricial retraction of the skin by cauterization; group d, by excision of a strip of skin near the border of the lid; group e, by excision of a bundle of muscle fibers near the border of the lid; group f, by section of fibers at the lateral raphe as in canthoplasty.

Class II. Correction of Faulty Position of the Cilia.

Group a, by removal as by epilation or electrolysis; group b, by

complete removal of the cilia border; group c, by displacement of the cilia border so that the hairs will not turn inward.

Operations on cases included in group *c*, Class II frequently exhibit the principles described in Class III.

Class III. Treatment of the Free Border of the Lid.

Group a, by allowing it to heal by granulation after displacement of the cilia border; group b, by implantation of pedunculated or non-pedunculated flaps of skin; or group c, by flaps of mucous membrane (marginoplasty).

Class IV. Correction of Distortion and Incurving of the Tarsus.

Group a, by tension sutures; group b, by section or partial excision; or group c, by combination of groups a and b.

CLASS I. CORRECTION OF SPASTIC CONDITIONS OF THE FIBERS OF THE ORBICULARIS.

As has been said, spastic entropion usually affects the lower lid and occurs in elderly people with relaxed, flabby skin, and in those in whom the support of the lower lid is partly lost, as from shrunken orbital tissue. It frequently occurs in such persons as a result of continuous bandaging of the eyes, and in these cases is usually relieved by discontinuing the bandage. If for any reason this cannot be done, it may be necessary to use mechanical or even operative measures to correct the difficulty.

Group b. Temporary Tension on the Skin by Adhesive Strips or by Sutures.

The end of a strip of adhesive plaster, half an inch or more in width, may be applied to the lid just below the cilia, then enough traction is made to slightly evert the lid and about two or three inches of the strip is made to adhere to the cheek. The moisture of the tears will usually make this a temporary expedient, and the strip may have to be reapplied with each dressing.

One may employ strips of gauze stuck to the skin with flexible collodion, which makes a more efficient dressing than the adhesive plaster. One end of a strip of gauze is applied to the lid as was the adhesive, and made to adhere by painting it with collodion. After this has dried, the necessary amount of traction can be made to evert the lid and then the whole strip, two or three inches long, can be made to adhere to the cheek. That the eye should be carefully protected from the ether in the collodion scarcely needs mention.

If these measures are not sufficient to keep the lid from turning inward, recourse must be had to sutures placed in the lid, and allowed to remain until the necessity of keeping a bandage on the eye has passed.

Gaillard-Arlt Suture.

According to Arlt[1] the method of shortening and everting the lid by means of a suture was first suggested by Wardrop.

Gaillard[2] carried out the idea by introducing the sutures into the lid in the following manner. The needle entered the skin of the lid not far from the inner angle of the eye and slightly beneath the lashes. It passed downward beneath the fibers of the orbicularis and emerged about 2 cm. lower down. A similar suture was placed near the outer angle of the lid. The sutures were firmly tied and allowed to cut themselves out. The resulting linear sears were expected to produce a more or less lasting result.

Arlt modified this procedure and the Gaillard-Arlt suture is applied in the following way. (See the illustration). Two sutures, each armed with two needles, are used. Holding a fold of skin of the lower lid between the finger and thumb, one of the needles is passed into the skin about 3 or 4 mm. from the lid border, at the junction of the inner and middle thirds of the lid, and made to emerge at the outer side of the fold. The other needle on the same suture is then passed in a similar direction, entering the skin about 3 mm. from the point of entrance of the first and emerging the same distance from the point of exit of the first. The points of exit should be not less than 15 mm. below the points of entrance of the sutures. The other surture is passed in a similar manner, at the junction of the middle and outer thirds of the lid. There are thus formed two loops on the skin, a few millimeters from the lid border, the threads passing below the fibers of the orbicularis. The sutures are tied over small rolls of gauze or pieces of tubing, and a small roll of the same is also inserted beneath each loop, to prevent it cutting into the skin. When tightening and tying the sutures, slight pressure is made against the tarsus with a probe, to facilitate the eversion of the lid. The sutures are usually removed after two or three days. The result is a temporary one, but it may be sufficient to relieve the condition until the dressings that were the cause of the trouble can be removed. If suppuration should occur along the track of the sutures, the resulting strands of scar tissue might produce a more or less permanent effect. This effect was formerly sought, but other operations may be done that are more efficient when a permanent effect is desired.

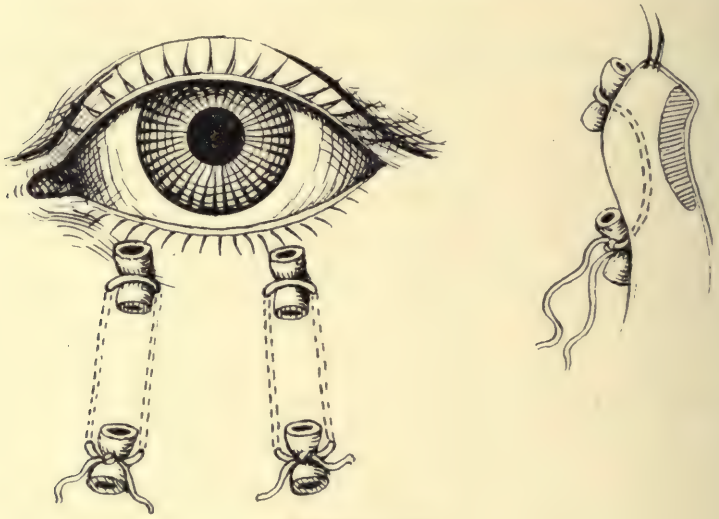
Snellen's Suture for Entropion.[3]

The eyelid may be held with the fingers or seized at the free border with a pair of forceps. A pair of T-forceps is also suitable for this

[1]Arlt. *Handbuch der gesam. Augenheilk., Graefe-Saemisch*, Vol. III, p. 457, 1874.

[2]Gaillard. *Bulletins de la soc. méd. de Poictiers*, 1844.

purpose. One needle of a double-armed suture is then passed from the fornix of the conjunctiva directly through the lid and at right angles to it. It is then made to re-enter the skin at the point of exit and is passed upwards beneath the skin to within a few millimeters of the eyelash border. The second needle on the suture enters the fornix about 4 mm. from the entrance of the first, passes through the lid, enters beneath the skin and emerges at the free border about 4 mm. from the point of exit of the first. The ends of the thread are then tied over a small roll of gauze or piece of small tubing. Two or three looped sutures may be applied at equal intervals, and the effect, when they are tied, is to turn out the lid border; for the point of fixed support is the tarso-orbital fascia near the orbital margin, and tightening



Figs. 784, 785.
Gaillard-Arlt Suture for Spastic Entropion.

the suture tends to straighten the arc formed by the line of the suture. A bandage may be applied and the sutures removed at the end of three or four days.

Gillet de Grandmont[4] modifies the suture of Snellen by passing it directly from the inferior conjunctival cul-de-sac to the lid border without having it emerge through the skin. A double-armed suture similar to the Snellen is used, and the points of entrance in the cul-de-sac are about 4 mm. apart. The sutures are tied over a roll as in the case of the Snellen suture.

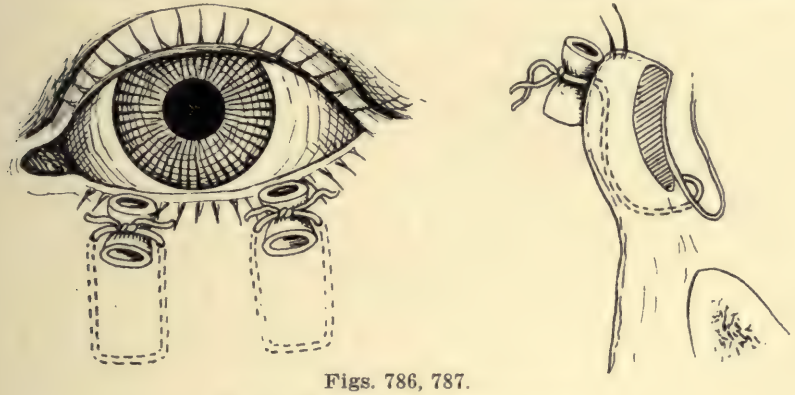
---

[3]Snellen. *Congrès internat. d'Ophtal.*, Paris, 1862, p. 236.
[4]Gillet de Grandmont. *Bull. de la Soc. d'Ophtal. de Paris*, I, 1889.

Boeckmann[5] uses loop sutures in spastic entropion in the following manner: The needles of a double-armed suture of silk or catgut are passed entirely through the lid from the conjunctival side, the point of entrance is just below the tarsus for the lower lid and slightly above the tarsus for the upper lid. The points of emergence of the suture in the skin are nearer the edge of the lid than the points of entrance. He uses one suture for spastic entropion of the lower lid; three for the upper. The sutures are tied tightly without any roll and are removed after four or five days.

Allport[6] practises about the same procedure as described by Boeckmann for spastic entropion, passing three loop sutures through the lid at the level of the convex border of the tarsus and tying them tightly, thus fixing the fibers of the orbicularis to the tarsus at these points.

Dransart[7] has used the suture of Gillet de Grandmont successfully



Figs. 786, 787.
Snellen's Suture for Entropion.

in entropion of the upper lid and has found it effectual in cicatricial entropion of the lower lid.

It will be seen that all of these suture operations act by exerting tension upon the skin from a fixed point of support which is in the tarso-orbital fascia, and that the nearer the suture emerges to the free border, the greater will be its power to effect eversion of the lid. Furthermore, the effect of the operation will be temporary unless the suture remains long enough to allow cicatricial bands to form along its track.

Montgomery[8] passed a single suture the length of the tarsus of the

---

[5]Boeckmann. *Norsk Magazin f. Laegevidensk*, 1880. Vol. XI; also, personal communication.

[6]Allport. Operation for Simple forms of Entropion. *Amer. Journ. of Ophth.*, March, 1888, p. 78.

[7]Dransart. *Journal d'Oculistique du nord de la France*, Feb., 1890, p. 69.

[8]Montgomery. *Chicago Med. Journ. and Examiner*, 1886.

lower lid, parallel to the lid border and about 4 or 5 mm. from the line of cilia. The needle entered at a point near the external commissure, passed beneath the muscle and along the tarsus, to emerge at a point 4 or 5 mm. below the punctum lachrymale. The suture was tied directly over the skin, and, if a temporary result was desired, was removed at the end of 4 or 5 days, or, if a more permanent result was to be obtained, it was allowed to cut its way out, thus producing a linear scar giving a similar result to that obtained by cauterization.

Class I, Group c. Correction of Spastic Entropion by Cicatricial Contraction of the Skin by Cauterization.

Cauterization, in one form or another, has been used for the correction of entropion since the time of the ancient Egyptians who are said to have burned the lids with red-hot, gold plates, to destroy the cilia and produce cicatrices. The Arabian physicians of the XIth and XIIth centuries used the red-hot iron for the same purpose.

More recent operators[9] (Galezowski, Trousseau, Terrien), have substituted the thermo-cautery or galvano-cautery and have practised much the same procedure as their predecessors. Either with the fingers or with a lid clamp (one blade of which is inserted in the conjunctival sac) a fold of the palpebral skin is raised, and with a small blade of the cautery a line is traced, 3 or 4 mm. from the eyelash border, along the whole length of the lid. The tissues along this line are burned through to the tarsus. General anesthesia may be required.

Ziegler[10] obtains good results in entropion of a spastic form by a somewhat similar procedure. The lid is held in the author's special lid clamp, the distal edge of which is straight. At a distance of 4 mm. from the free border, the short point of a galvano-cautery is passed through the skin and into the tarsus. Several such cauterized punctures are made 4 mm. from each other along the same line. Infiltration anesthesia, or slightly freezing the skin with a spray of ethyl chlorid may be sufficient, but in many cases ether or chloroform narcosis is necessary. The author also employs the same method in ectropion, the line of punctures then being made on the conjunctival surface.

Chemical caustics have also been used for producing cicatricial contraction of the skin in these cases. Quadri and Helling employed sulphuric acid; Vienna paste has been recommended, and Theobald[11] advocates, for senile entropion of the lower lid with relaxed tissues, the use of caustic potash. With a finely pointed crayon of potassium

---

[9] *Encyclopédie française d'Ophtalmologie*, Vol. IX, p. 159.

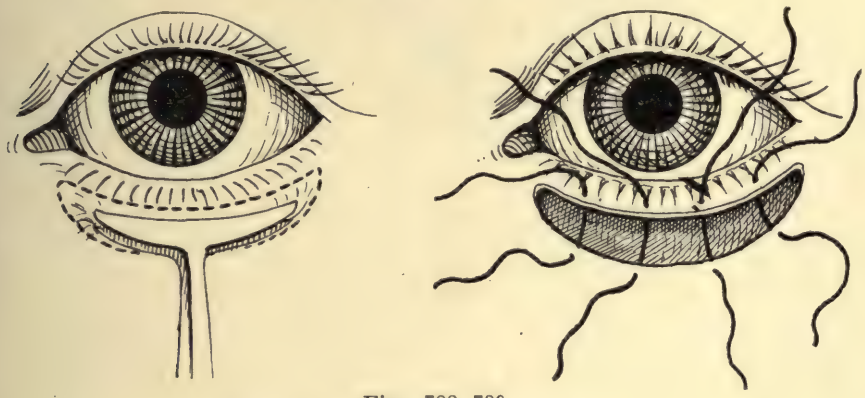
[10] Ziegler. *Journ. Amer. Med. Assoc.*, 1909, Vol. LIII, p. 183.

[11] Theobald. Treatment of Entropion of the Lower Lid with Caustic Potash. *Amer. Journ. of Ophthal.*, Oct., 1898, p. 295.

hydrate he makes an eschar 3 or 4 mm. wide, parallel with the lid margin and extending the length of the tarsus. The crayon is drawn back and forth several times over this area, care being taken not to get nearer than 3 mm. to the lid border. When the skin has been destroyed and the deeper tissues assume a brownish color, the action of the caustic should be stopped by applying acetic acid diluted one-half. A simple dressing is all that is required. If the first application proves insufficient it may be repeated.

Class I, Group d. Correction of Entropion by Excision of Skin Near the Border of the Lid.

Operations of this class have been practised since the earliest times. Celsus advised this method, and Paulus Ægineta is said to have devised a special lid forceps, possibly somewhat like the modern T forceps, with which to seize the piece of skin before excising it.



Figs. 788, 789.
Operation for Spastic Senile Entropion.

In many of these operations the fibers of the orbicularis are included in the piece excised, and without doubt a part of the good effect is due to this, the sphincter action of the orbicularis being in this way temporarily checked. Some of them are combined with canthotomy or canthoplasty, whereby their effect is increased. A simple, but very effective operation of this class, the origin of which probably dates back to antiquity, is excision of a horizontal fold of skin, with, possibly, some fibers of the orbicularis, parallel to the lid border.

With a T forceps a horizontal fold of skin of the lower lid is seized, the amount included in the grasp of the forceps being just enough to produce the desired amount of eversion of the lid, the forceps being so placed that the upper incision will fall about 3 mm. beneath the line of the cilia. The incision is made with an ordinary scalpel, or the skin may be transfixed by a Beer's knife along the line to be cut, the back

resting on the lid. This incision, extending nearly the length of the lid, is joined at either end by a slightly curved one below this. The skin and muscle fibers are removed and the lips of the wound brought together with three or four sutures. (See the accompanying figure). Care must be taken that too much tissue is not removed, lest an ectropion follow. The amount to be taken must be measured by pinching up a fold either with the T forceps or with small toothed forceps. The resulting scar is slight and not very noticeable. This operation is

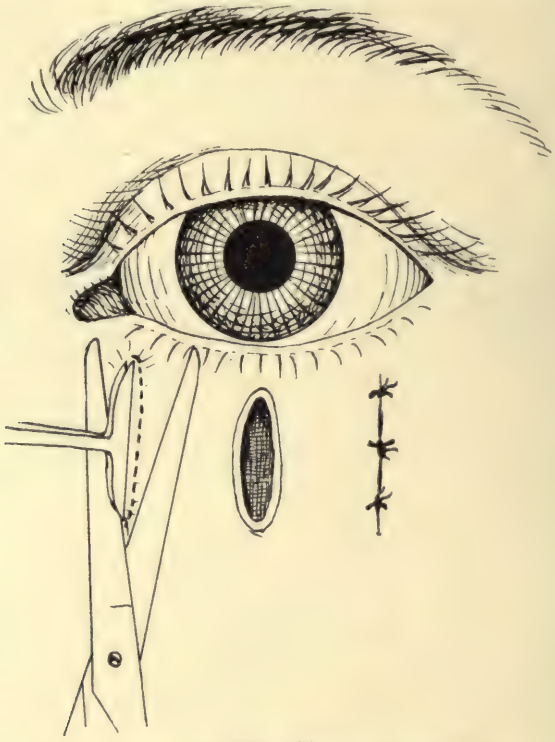


Fig. 790.
Janson's Operation for Spastic Entropion.

applicable in senile entropion associated with considerable redundancy of skin.

The operation of Janson[12] (Figure 790) is a revival of an ancient operation and consists in cutting out of the lower lid one or more oval pieces of skin. A fold of integument at right angles to the free border of the lid is seized with a pair of T forceps and excised with scissors. The lips of the wound are then approximated with sutures. Two or three such cuts are made according to the degree of the entropion. The

[12]Janson. Desmarres' *Traité des Maladies des Yeux*, 1847, Vol. 1, p. 497.

chief disadvantage of this method is that the degree of eversion cannot be accurately determined. Moreover, vertical scars are unsightly and may cause by their contraction a subsequent ectropion.

Busch,[13] in 1858, proposed an operation not only for spastic entropion but for certain cases of mild cicatricial entropion of the lower lids, that has merits. A canthotomy of about 1 cm. in length is first done. From the ends of this incision two incisions downward are made to include a triangular piece of skin which is then excised. The closure of the triangular gap in the skin with sutures, horizontally placed, everts the lid.

Goldzieher[14] has adapted this operation for cases of purely spastic senile entropion by omitting the canthotomy (which it must be conceded is a useful feature) and removing a triangle of skin about 5 mm. from the outer angle of the lids. The base of the triangle is about 2 cm. in length with its apex pointing downward and inward toward the cheek. The skin is excised and the sutures are placed so as to exert traction downward and outward.

Graefe's Operation for Entropion Spasticum.

This operation[15] consists in a removal of a triangular piece of skin from the lower lid in the following manner. An incision is made about 3 mm. from the lid border extending nearly the entire length of the lid. At the junction of the middle and outer thirds of this incision two others are made converging downwards, of such length as to mark out an equilateral triangle (see the diagram). The skin composing this triangle is then dissected off, and the skin at *b* and *c* is undermined. The lateral borders of the gap are then approximated with sutures.

A couple of fine stitches may be used to close the horizontal cut. If the first incision has been properly made, 3 mm. from the lid border, the upper suture will pass over the inferior border of the tarsus and by shortening the tissues of the lid at this point, press the inferior border of the tarsus backward and thus turn the superior border forward. This action may be aided by placing a small roll of gauze on this point, to be held in place by the dressing. The sutures may be removed in three or four days. Before applying the sutures, the upper skin flap can, if desired, be slightly dissected back with scissors and the attached fibers of the orbicularis removed. In cases of cicatricial entropion Graefe advocated the same procedure with the additional removal of

---

[13]Busch. Beitrag zur Operation des Entropiums. *Archiv. f. Ophth.*, Vol. IV, Pt. 2, p. 107.

[14]Goldzieher. Ueber Entropium spasticum senile und seine Heilung. *Klin. Monastbl. f. Augenh.*, 1908, Vol. XLVI, p. 426.

[15]Graefe. Bemerkungen zur Operation des Entropium und Ectropium. *Archiv. f. Ophth*, 1864, Vol. X, Pt. 2, p. 221.

a triangular piece of the tarsus as indicated by the dotted lines in Fig. ——. The objection to the method is the vertical scar that is left, but aside from this it remains one of the valuable methods for the correction of the trouble.

Entropion Operation of Panas.

Panas[16] proposed the following modification of excision of the skin, which may also include excision of some of the fibers of the orbicularis, for the relief of entropion of the lower lid (see Fig. 792). At each extremity of the lid, beginning 3 mm. below the free border, a vertical incision is made through the skin 1 cm. in length. The lower extremities are joined by an incision through the skin.

The flap thus marked out, is dissected away from the underlying tissue up to the free border of the lid. By making traction downward

Fig. 791.

Graefe's Operation for Entropion.

Incision from *a* to *b*. Converging Incision from *c* to *e* and *d* to *e*. Triangular Piece of Skin removed. The dotted Triangle Indicates where the Piece of Tarsus is excised. Sutures as Indicated.

on this flap, one can now determine how much tissue along its lower border it is necessary to remove in order to produce the required eversion of the lashes. One may also excise some of the fibers of the orbicularis lying just beneath the free border of the lid. Sutures are placed, as indicated in the cut, to close the wound. The resulting scar is not considerable, and is largely concealed by the natural folds of the skin.

Class I. Group e. Correction of Entropion by Excision of a Bundle of Muscle Fibers Near the Lid Border.

It will be seen that many operations designed to correct entropion

[16]Panas. *Maladies des Yeux*, Vol. II, p. 155.

by the removal of a strip of skin, combine with this the removal of some fibers of the orbicularis, to check the spastic action of this muscle. Indeed, it seems probable that a certain amount of the good effect produced is the result of such muscular excision, and the same might be said of the operations by cauterization, which also destroys some of the muscle bundles and thus limits, for a time at least, the sphincter action of the orbicularis. This is an important feature of some of the best operations for entropion, whether of the spastic or cicatricial variety, for even in the latter variety, owing to the constant irritation of the eye, there is usually more or less spasm of the muscle, and the removal of a portion of it tends to check the spasm. This principle will be referred to in operations to be later described.

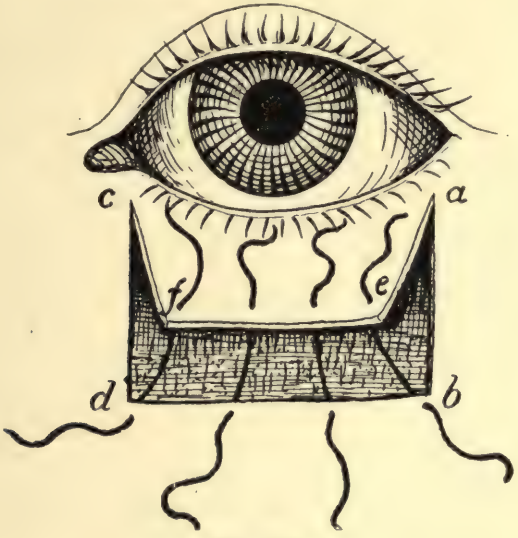


Fig. 792.

Panas' Operation for Senile Spastic Entropion.

Vertical Incisions are made from *a* to *b* and *c* to *d*, and a connecting Horizontal Incision from *b* to *d*. The Flap, *a*, *e*, *f*, *c*, is dissected up to the Free Border, and then sufficiently Shortened to Produce the Desired Result. Sutures are then placed at the Points indicated.

Class I. Group f. Correction of Entropion by Section of the Fibers of the Orbicularis at the Lateral Raphe.

What was said above applies equally well here. The division of the outer canthus as in canthotomy and canthoplasty (q. v.) involves cutting the fibers of the orbicularis that attach them to the lateral raphe. When canthoplasty is used as an aid to operations for entropion one should snip, with pointed scissors introduced into the wound, the fibers of the ligament above and below.

CLASS II. CORRECTION OF FAULTY POSITIONS OF THE CILIA.

Group a. Removal of the Cilia in Trichiasis.

When trichiasis is limited to a small part of the lid, or when a few of the cilia are misplaced and, turning inward, irritate the eyeball, they should be removed either by *epilation* or, better, by *electrolysis*. The misplaced hairs are sometimes so fine and so light colored that a careful search with good illumination and the aid of a lens is necessary to discover them. If epilation is practised the hair is seized near its base with cilia forceps and gently drawn (*not* jerked) in the direction of the shaft. *Cilia forceps* (q. v.) as manufactured by most instrument makers are ordinarily very imperfect, and many of them are quite useless for the purpose for which they are intended. The opposing surfaces at the ends of the blades should come into perfect apposition, otherwise fine hairs will not be caught. In selecting such an instrument one should subject it to the test of holding it up to a light with the blades closed, and noting whether any light can be seen between the apposed surfaces at the ends of the blades. Too frequently it will be found that the surfaces come into actual contact at one small point only.

Even after proper epilation, however, it is only a matter of time until the hairs grow again, so that it is much better to destroy the hair follicles by means of electrolysis.

Electrolytic Epilation.

It is best to place the patient in a recumbent posture and in a good light; oblique illumination should be used if the light is artificial. The operation is rather painful, so that if a number of hairs are to be removed at one treatment it is best to inject into the edge of the lid a drop or two of a 1 per cent. cocaine solution, in addition to cocainizing the conjunctiva. This will make less painful the application of some kind of lid clamp, or the lid spatula of Jaeger (q. v.), which will be useful to give good support to the lid.

A very fine needle, or a fine drill such as is used by jewelers, is mounted in a suitable handle that can be connected with the negative pole of a galvanic battery, which should be provided with a rheostat and a galvanometer. A wet sponge electrode connected with the positive pole is applied to the neck or cheek of the patient.*

The operator should use a binocular loupe (such as Jackson's or Berger's) in order to pass the needle accurately along the shaft of the

*If the operator is in doubt as to the polarity of the current he can easily determine it by immersing two metallic electrodes in a glass of water, and noting that when the current is turned on, a greater number of bubbles of gas (hydrogen) accumulate around the *negative* pole, than around the *positive* (oxygen).

hair into its follicle. When the needle has been thus passed into the follicle to a depth of 2 mm. to 3 mm. and the sponge electrode has been applied to the cheek, the current is turned on and controlled by the rheostat until the galvanometer shows a current of 0.5 to 1 milliampere. Electrolytic action is shown by the bubbles of gas that accumulate around the needle and hair shaft. When this has been continued for nearly half a minute, the current is gently turned off and the needle withdrawn. The dead hair can then be easily extracted with the cilia forceps. If any resistance is encountered in extracting it, it is evidence that the electrolysis around the hair root is not complete, either because the current was not applied long enough or, more probably, because the needle was not accurately placed in the follicle. Considerable care is necessary in thus epilating the very fine hairs that are so frequently the cause of great annoyance, but the result amply repays the effort.

Class II, Group b. Complete Removal of the Cilia Border in Trichiasis.

The operation of "scalping the lids" is one that is now rarely performed, although in extremely obstinate cases it may be practised. Naturally, it is more to be avoided on the upper than the lower lid, for the lashes of the upper lid are more essential to protection of the eye than those of the lower. It was probably suggested by the practice of the ancients of completely destroying the hair follicles by a hot iron. The method that is usually followed is that suggested by Flarer.[17]

Flarer's Operation.

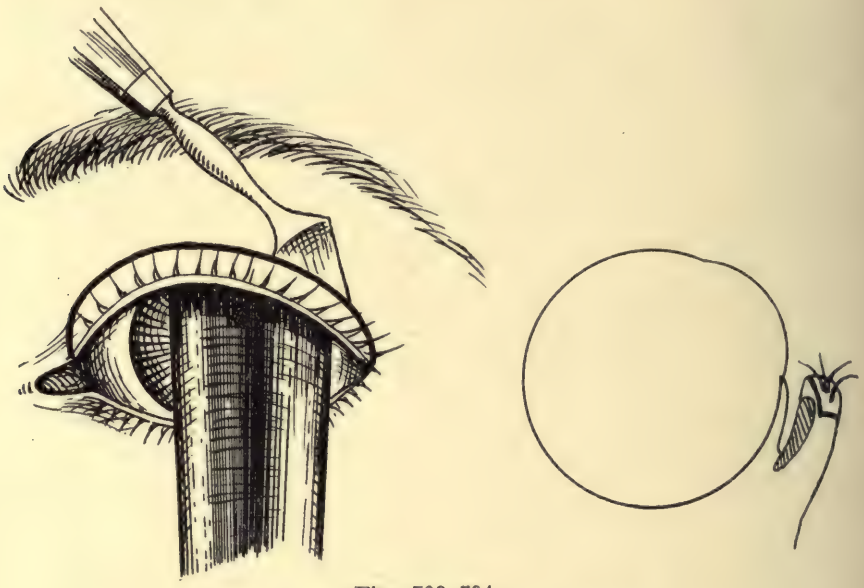
Either a horn plate, such as Jaeger's lid spatula, or a broad lid-clamp is placed beneath the lid, to hold it firmly and give support. With either a keratome or a narrow scalpel, such as a Graefe cataract knife, an incision is made along the whole length of the free border of the lid, splitting it into two layers. In making this incision the gray line is followed that lies between the openings of the Meibomian glands and the row of cilia. In cases where the posterior margin is rounded off, and the row of cilia is more or less distorted, this grey line is not well defined, and then the operator *in making this intermarginal incision must take care that all the cilia lie in front of it.* The incision thus passes into the loose connective tissue that separates the orbicularis from the tarsus, and should extend in depth about 3 mm., or beyond the depth of the hair follicles.

An incision is then made in the skin, parallel to and about 3 mm. from the free border, and at each extremity of this another curved cut is made meeting the ends of the intermarginal incision. This strip, containing the cilia, is easily dissected off. Care should be taken that all the roots of the hairs are removed. Any black points that remain

[17] Flarer. *Riflessioni sulla trichiasi.* Milan, 1828.

should be dissected out with scissors. The raw surface, which heals by granulation in a few days, may be covered with a moist boric acid dressing.

The disadvantages of this method are obvious. It causes an unsightly appearance, removes structures important for the protection of the eyeball and in cases where entropion is a marked feature leaves a harsh scar at the lid border that often irritates the eyeball as much as did the hairs. It has received an important modification by Stellwag, which is applicable to cases in which trichiasis, rather than entropion, is the dominant feature of the case.



Figs. 793, 794.

Flarer-Stellwag Operation for Entropion.

The Cilia Border is Removed by Splitting the Lid Margin along the Gray Line, and then making an Incision 3 mm. from the Free Border. The Flap thus excised is then Reversed.

Flarer-Stellwag[18] Operation for Trichiasis.

The operation (Fig. 793) is performed in every respect like the one just described, with this addition. After the strip of tissue bearing the cilia has been removed, it is placed in warm normal-salt solution (0.5 per cent.) until the bleeding of the raw surface at the edge of the lid is checked. The narrow flap is then placed in a *reversed position* on the raw surface (*i. e.*, what was the temporal end of the strip is placed at the nasal end of the denuded area), and is

[18] v. Stellwag. Ein neues Verfahren gegen einwärts gekehrte Wimpern. *Allgemeine Wiener med. Zeitg.*, 1883, Nr. 49.

gently fitted into position. A very fine stitch at either end may or may not be necessary. The little flap is sprinkled thickly with iodoform powder, and the wound is then covered with rubber tissue, or silk protective, that has been smeared over with vaseline. Over this the dressing is placed. Both eyes should be bandaged for two days to prevent, as far as possible, movement of the lids. The dressings may be changed every day after this. The lashes in the strip usually fall out, but if the flap is retained as it usually is, the lid border although bald, does not present the disfiguring and irritating scar surface that it would, after the scalping process.

Naturally, this method is more applicable to cases in which the whole row of eyelashes is symmetrically turned inward than in those where the hairs are straggling, some of them pointing inwards and many of them outwards.

Although this operation should, according to the plan outlined, be considered in Class IV under treatment of the free border of the lid by processes of grafting, it was thought best to present it here as a modification of the ablation operation, and as naturally leading up to a study of the procedures described in the following division.

Class II, Group c. Correction of Faulty Positions of the Cilia by Displacement of the Cilia Border.

Operations of this group attempt to displace or transplant the cilia border in such a way that the lashes will not come in contact with the eyeball.

Attempts to correct trichiasis in this manner were probably made by the older physicians, and, it is said that the operation, presently to be described as that of Jaesche-Arlt, is identical with the one described by Paulus Ægineta in the seventh century.

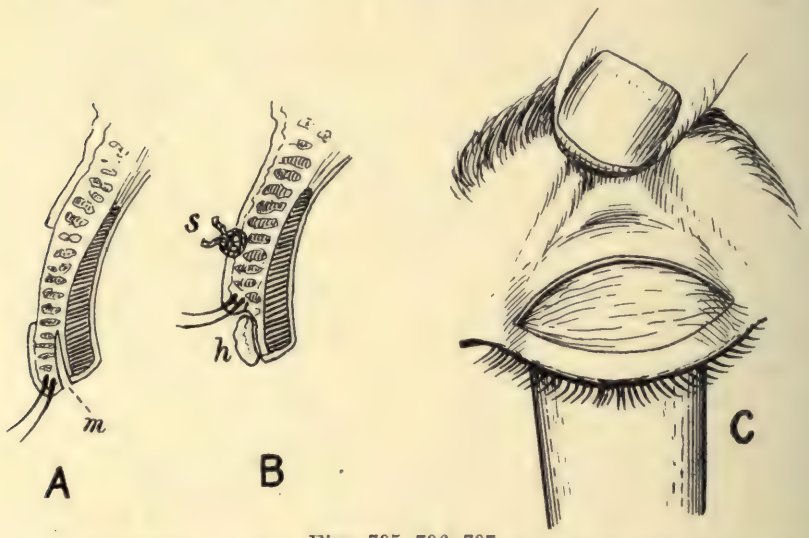
In most of the operations of this class, in addition to transplanting the cilia-bearing zone away from the free border of the lid, there is introduced the plastic feature of covering the denuded area with skin or mucous membrane, in the attempt to prevent as far as possible the formation of scar tissue on the free border.

Operation of Jaesche-Arlt.[19]

An intermarginal incision, similar to that described in the Flarer method (q. v.) is made along the whole length of the lid, following the gray line on the free border. This incision should be 3 or 4 mm. in depth, and should be so placed that all the lashes will be in the anterior layer which is separated from the tarsus. A fold of skin is next removed from the anterior surface of the lid in the following manner. An

[19]Jaesche. *Med. Zeitung Russlands*, 1844, No. 9. Arlt. *Graefe-Saemisch Handbuch der ges. Augenh.*, 1st Ed., Vol. III, p. 447.

incision is made in the skin parallel to the free border and about 4 mm. from it; above this and joining it at each end, there is made a curved incision through the skin, which marks out a crescentic area of skin that at its widest part at the middle of the lid is about 8 mm. This crescentic piece of skin is then dissected off with blunt-pointed scissors or scalpel, care being taken not to buttonhole it, and not to remove the subjacent fibers. The gap produced by the excision of this piece of skin is then closed by five or six sutures. Arlt recommends that, in placing them, the needle first pass through the skin of the upper edge of the cilia flap, then include some of the orbicularis fibers over the tarsus and, finally, the skin of the upper lip of the wound. The sutures are not cut off, but are drawn upwards to cause the cilia border to



Figs. 795, 796, 797.

Transplantation of the Bed of Hair Follicles by the Method of Jaesche-Arlt.

A, Cutaneous Incision and Incision in the Intermarginal Line, *m*.

B. After Tying the Cutaneous Sutures, *s*, and implanting the piece of Skin, *h*.

C. Front View after Excision of the Skin has been done, with the Horn Plate inserted.

take its new position higher up on the tarsus, and are secured to the forehead over the brow by an adhesive strip. The raw surface below the cilia border is allowed to heal by granulation. This objectionable feature is overcome by the plastic modification suggested by Waldhauer[20] of placing the excised strip of skin on the raw border, and the

[20]Waldhauer. Bericht der Section für Augenheilkunde der 55. Versammlung deutscher Naturforscher und Aerzte zu Eisenach. *Klin. Monatsbl. f. Augenh.*, 1883, XXI, p. 432.

operation is usually practised now with this valuable modification. After excising the strip of skin, which should be as thin as possible, it is placed in warm 0.5 per cent. NaCl solution until the wound in the skin has been closed, as described, and the bleeding at the border of the lid has been completely checked. It can then be placed in position on the raw border of the lid, and if necessary trimmed a little, to make it fit exactly. This trimming should be done with scissors, only after the flap is in position and held by an assistant. In most cases sutures are unnecessary, but possibly a fine one may be placed at each end and one in the middle, if the flap is not nicely apposed.

Care should be taken not to excise too wide a piece of skin lest ectropion result. To avoid this, before making the skin incision, the operator should estimate the amount required by pinching up a fold of skin and noting the effect on the lid border.

As in all cases of transplantation of skin flaps, strips of rubber tissue or oiled silk should be placed over the wounds before applying the dressing. The wound should be dressed each day, and at the end of the second day traction on the sutures may be released. The wound should have healed sufficiently by the fourth or fifth day to allow the removal of the sutures. Should the flap slough, it will be necessary to cover the granulating area with a piece of hairless skin taken from behind the ear, or with a piece of mucous membrane from the inner surface of the lip.

Indications for the Jaesche-Arlt Operation. This operation, with the important modification of Waldhauer, may be practised either upon the upper or lower lid. It is more applicable in cases of partial or complete trichiasis in which there is no marked distortion or incurving of the tarsus. It has no power to correct the latter condition, because the sutures have no fixed point of support, and in such cases one must have recourse to some tarso-plastic operation.

Graefe,[21] observing that the misplaced cilia at the extremities of the lid were not controlled by this method, modified it in the following manner. At each end of the intermarginal incision vertical incisions were made through skin and muscle, so that the whole cilia border could slide upward. There was then excised from the upper lid an oval piece of skin of such a size that the closure of the resulting gap would draw up the detached lid border, or loop sutures were placed and tied over rolls, to remain a few days until the lid border had become fixed in its position. The new border was then allowed to heal by granulation.

DeWecker[22] recommended, as a modification of the Jaesche-Arlt

[21] Graefe. Bemerkungen zur Operation des Entropium und Ectropium. *Archiv. f. Ophthal.*, Vol. X, 2, p. 221.

[22] de Wecker. Eine leicht ausfuhrbare und sehr wirksame Trichiasis-Operation. *Klin. Monatsb. f. Augenh.*, 1879, p. 141.

method, making first a canthoplasty; then, after an intermarginal incision, hoding back the detached cilia border by the application of 3 or 4 Gaillard sutures. He allowed the border to granulate. The procedure of Bauchon[23] was very similar to that of de Wecker.

Landolt's Operation for the Relief of Trichiasis.

Landolt[24] changed the position of the cilia in the following rather complicated and ingenious manner. The margin of the lid was split along the gray line, as in the Jaesche-Arlt method, but the incision was made much deeper, so that all the tissues were separated from the anterior face of the tarsus. This dissection of the lid into two layers is done with scalpel and scissors. An incision (Fig. 798) is then made from one angle of the lid to the other, parallel to and about 3 mm. from the lid border, through the anterior layer to the tarsus. There is thus formed a bridge of tissue that includes the cilia border.

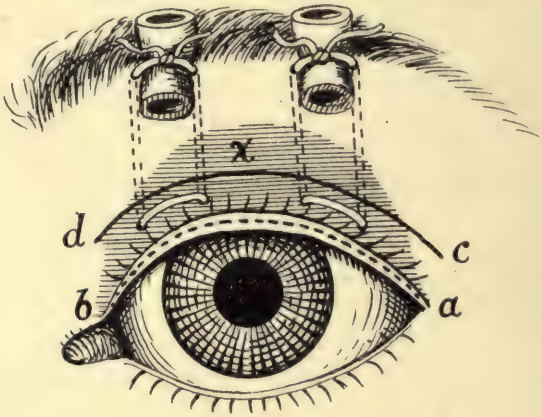


Fig. 798.

Landolt's Operation for Trichiasis.

The Lid is split along the Border shown by the Dotted Line, *a*, *b*, and all the Tissues Separated from the Tarsus up to or above its Superior Border, Indicated in the cut by the Shaded Portion. An Incision, *c*, *d*, is then made 3 mm. from the Lid Border, and this Bridge of Tissue, *a*, *b*, *c*, *d*, containing the Cilia, is drawn up under the upper Flap, *x*, by loop Sutures, as Shown in the Figure. The Lower Edger of the Flap, *x*, then comes down to Form the Border of the Lid.

The eyelashes are then cut off quite short, and this bridge of tissue is made to glide under the upper flap, which has been undermined, by means of two loop sutures which, placed at proper places in the bridge flap, pass under the upper flap and the skin and emerge from the skin at the eyebrow. Enough traction is made on these sutures to bury completely the cilia border under the upper flap, the lower edge

[23]Bauchon. *Annales d'Oculistique*, 1879, Vol. 81.

[24]Landolt. Un nouveau procédé d'opération dans le distichiasis. *Arch. d'Ophtal.*, Vol. X, 1890, p. 1.

of which comes down by its own weight, aided by a little traction, to form the border of the lid. The sutures are tied around a roll of gauze. After healing has taken place, and the bridge is attached in its new position to the tarsus, the sutures are removed. Another operation is done later, to liberate the eyelashes. This procedure consists in making an incision about 1 mm. from the new palpebral border, parallel to it, through which the cilia may escape.

Oettingen,[25] through a deep intermarginal incision, separated the anterior layer of the lid from the tarsus up to its superior border, so that the cilia zone could be drawn upward and fixed to a new position on the tarsus by means of sutures which were passed through the skin near the lashes and into the tarsus near its superior border.

The operation of Kostomiris[26] was done in much the same manner.

Class III. TREATMENT OF THE FREE BORDER OF THE LID.

Group a. By Allowing it to be Held by Granulation after Displacement of the Cilia Border.

This principle has already been considered in the description of the operations of Flarer, Jaesche, Arlt *et al.*

Group b. Treatment of the Free Border of the Lid by Implantation of Skin.

It was soon discovered that the margino-plastic principle was necessary to prevent the cicatrix at the lid border from drawing the cilia back into their old faulty position, and, so, in the evolution of operations for trichiasis and entropion this principle came to be used more and more. The first to make use of it was Spencer Watson,[27] whose operation marks a distinct advance in the treatment of trichiasis. He devised an operation for complete and another for partial trichiasis which will be described somewhat at length, because of its influence upon later operations of this class.

Operation of Spencer Watson for Complete Trichiasis.

An intermarginal incision is made, in the gray line mentioned, from one extremity of the lid to the other, about 3 or 4 mm. in depth, splitting the lid into two layers, exactly as in the operation of Jaesche-Arlt. An incision of the same length is then made, about 4 mm. from the cilia border and parallel with it, that extends through skin and muscle to the tarsus. By loosening this there is formed a bridge of tissue, *a, b, c, d,* containing all the structures of the lid border lying in

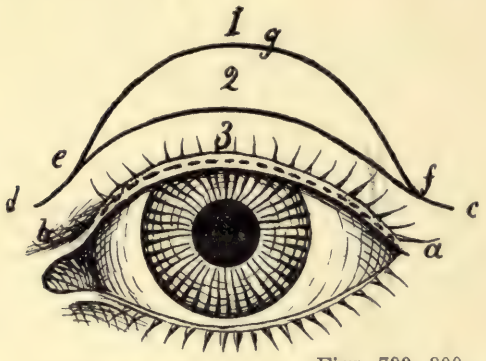
---

[25] Oettingen. *Dorpater Med. Zeitschr.*, 1871, Vol. XI., Pt. 1, p. 45.

[26] Kostomiris. *Wiener Med. Presse*, 1880.

[27] Watson. The Treatment of Trichiasis and Distichiasis by a Plastic Operation. *Med. Times & Gazette*, Vol. XLIX., 1874; Also A New Operation for Trichiasis and Distichiasis, with a Case. *Trans. Oph. Soc. U. K.*, Vol. XIV., p. 17.

front of the tarsus. (See Figure 799.) A third curved incision is then made through the skin and muscle of the lid, beginning about 6 mm. from one end of the skin incision, *c, d,* and meeting it about 6 mm. from the other end, *e, f.* This curved incision should pass through all the structures to but not into the tarsus. There is thus marked out by these two skin incisions an island of skin *c, d, e, f.* The tissues above this island are then lightly dissected back, so as to form a raw area into which is to fit the bridge bearing the cilia. The parts are then transposed so that the bridge of tissue is placed in the gap above the island where it may be secured by fine sutures, while the lower edge of the island is drawn down where it may be secured by two or three fine sutures. The usual moist dressing is applied and the sutures may be removed in a few days. This operation is a distinct improvement over the Jaesche-Arlt procedure in that no raw surface is left to granulate,



Figs. 799, 800.

Spencer Watson's Operation for Complete Trichiasis. First Stage.

Incision made through the skin to the Tarsus along the line *c. d.* Lid Margin split along the grey Line from *a* to *b*, and Bridge of Skin, 3, Dissected up from the Tarsus. Incision along the Line, *e, g, f,* to the Tarsus inclosing the Island of Skin, 2. (After Grimsdale and Brewerton).

and it removes the faulty cilia a safe distance from the eyeball. In this respect, however, it has no advantage over the Waldhauer modification of the Arlt operation, which was probably suggested by it. The fine hairs on the island of skin that is brought down to the lid border, may, if there is continuing entropion, turn inwards and irritate the eye. Like the preceding operations it is not sufficient when there is marked incurving of the tarsus.

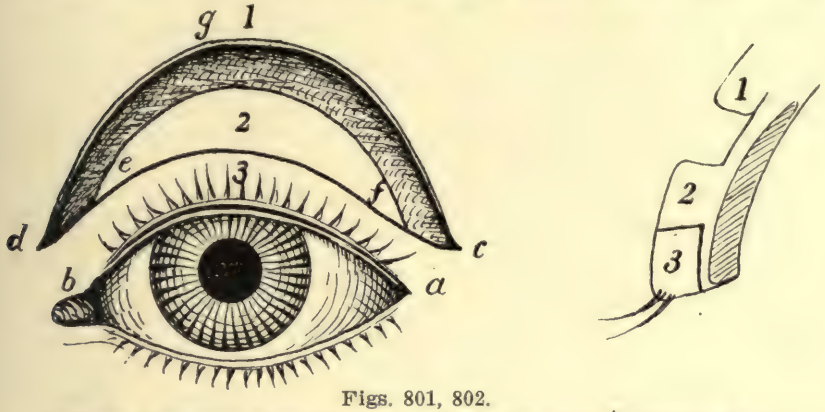
The fact that in many cases of entropion and trichiasis the deformity exists at one or other end of the lid suggested to Watson[28] an operation for partial trichiasis, based on the same principle.

---

[28]Spencer Watson. On a New Operation for Distichiasis, with a Successful Case. *Royal Lond. Ophthal. Hosp. Rep.*, Vol. VII, 1873, p. 440.

Operation of Spencer Watson for Partial Trichiasis.

An intermarginal incision is made along the gray line from the outer angle of the lid to a point 1 or 2 mm. beyond where the lashes are misplaced, so as to include all the offending zone. At the outer angle this incision passes into the skin 1 or 2 mm., makes a sharp turn

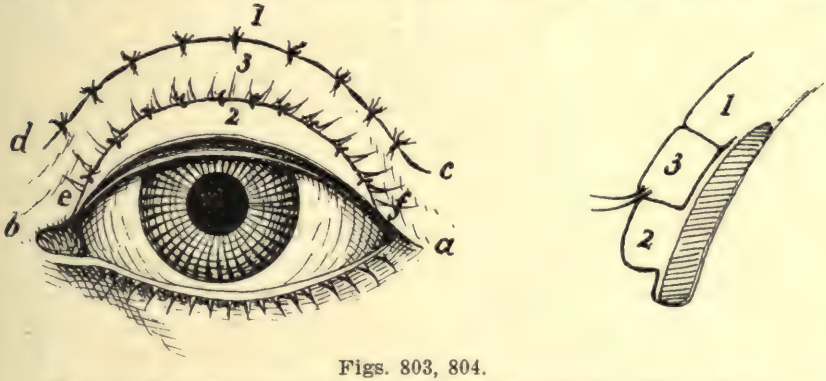


Figs. 801, 802.

Spencer Watson's Operation for Complete Trichiasis. Second Stage.

Tissues above the Island, 2, are lightly Dissected back, giving a Raw Area, *c*, *d*, *e*, *f*, *g*, into which the bridge of Skin from the Edge of the Lid is to be placed. (After Grimsdale and Brewerton).

and then continues with an incision that runs parallel to the free border about 3 or 4 mm. from it. It then extends up to a point corresponding to the intermarginal incision. At this point, with a sharp



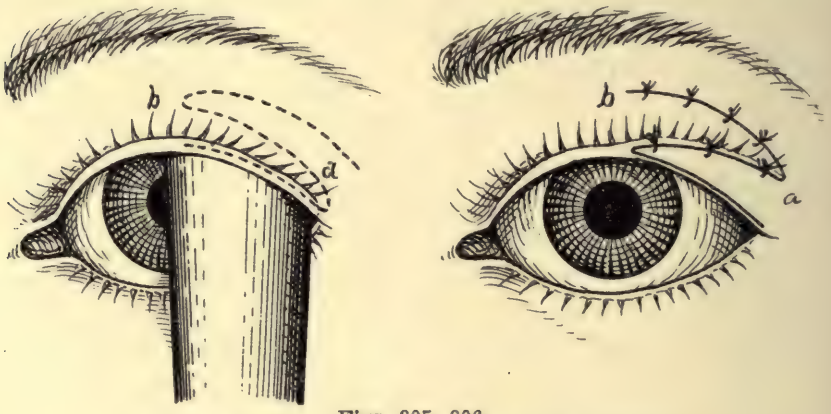
Figs. 803, 804.

Spencer Watson's Operation for Complete Trichiasis. Third Stage.

Bridge of Skin bearing the Eyelashes, *a*, *b*, *c*, *d*, placed in the Gap. The Island, 2, brought down to help cover the Denuded Margin of the Tarsus. (After Grimsdale and Brewerton).

turn, the incision is made toward the temple about 4 mm. above the preceding one. There are thus marked out two narrow, tongue-shaped flaps, the lower being the cilia border with its attached base toward the

center of the lid, the upper of skin, with its attached base toward the temple. The incisions should be so made that the tongue-shaped flaps will be somewhat longer than the intermarginal incision, to allow for shrinkage. The narrow, pedunculated flaps are then completely dissected from the underlying tissue, care being taken that the upper one includes only skin without the muscle fibers, while the lower one contains all the misplaced cilia. The flaps are then transposed so that the apex of the upper flap (see the figure) will take a position on the edge of the lid at the central end of the intermarginal incision and its lower border will form the border of the lid. The lower flap will take its place with the apex at the temporal end of the upper incision and the row of lashes in contact with the upper edge of flap *a*. The span of each flap can be united to the skin at the angle, where it is to rest,



Figs. 805, 806.

Spencer Watson's Operation for Partial Trichiasis.

A. Incision through the Gray Line separating the Flap, *b*, bearing the eyelashes. *a Upper Flap.*

B. Position of Flaps when Transposed. (After Czermak).

with a very fine suture, and a few fine sutures can be placed along the line of each flap, although not many, for the flaps are very delicate. None is required at the lid border. The handling of the narrow flaps is facilitated by placing the suture in the end of each before it is dissected off. Rubber tissue is placed over the wound and the usual moist dressing is applied.

The principal involved in Spencer Watson's method was followed by numerous operators, who make use of pedunculated flaps of skin or mucous membrane to fill in the gap after displacing the cilia border.

Nicati[29] practised a method almost identical with that of Spencer

[29]Nicati. *Marseille Médicale*, 1879, p. 99; also *Archiv. d'Ophtalmologie*, 1883, p. 395.

Watson for partial trichiasis, applicable to cases in which the lashes are misplaced at the palpebral extremities. (See the figure).

To this he gave the name "margino-plasty." It is performed by splitting that portion of the lid border that is affected, making an incision parallel to the lid border in part of its course and then directing it slightly upward to make a large base that will insure the viability of the flap. This flap, with its base toward the center of the lid and containing the cilia border, is then dissected up, while the lower edge of the skin just above it is drawn down to form the lid border. Then another cut is made in the skin surface at a suitable place to form a gap into which to plant the cilia border and to secure it with a few sutures.

Gayet,[30] observing that the long skin flaps made by the Spencer Watson operation were liable to necrosis, advised that the flaps include

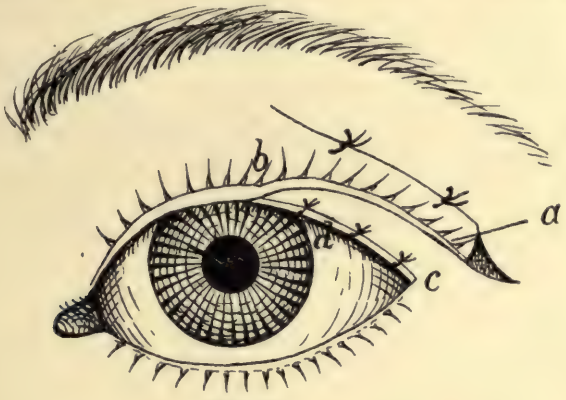


Fig. 807.

Operation of Nicati for Trichiasis.

The Lid border, *a*, *b*, is planted into a New Position. The Skin has been Drawn down to form the New Border, *c*, *d*.

all the tissues down to the tarsus. After freely splitting the lid, he placed in the gap a long narrow, pedunculated flap, with a base, as large as possible, outward. This flap was taken from the lid 2 or 3 mm. above the lid border.

Dianoux,[31] under the name *"auto-plastic palpébrale,"* suggested a method very similar to Spencer Watson's. He split the lid freely and made a bridge of the cilia border by an incision parallel to the free border and about 4 mm. from it. Above this incision and parallel to it another incision was made, and this was undermined so that a second

[30] Gayet. De la Cure de l'Entropion par une Operation Autoplastique. *Annales d'Oculistique*, 1882, Vol. 87, p. 27.

[31] Dianoux. De l'Autoplastie Palpébrale par le Procédé de Gayet. *Annales d'Oculistique*, 1882, Vol. 88, p. 132.

bridge, of integument alone, was made. (See the illustrations). These bridges were then transposed so that the lower edge of the upper one came to the border of the lid. When the flaps were healed in place, the one forming the lid border was freed by an incision at each end.

Truc and Villard[32] make use of a pedunculated flap for curving the lid border, essentially as accomplished in the Spencer Watson operation.

The introduction of pedunculated flaps to restore the lid border, after suitably displacing the zone of cilia, marks a distinct advance in the treatment of trichiasis, although it does not correct the deformity of the tarsus incident to the contraction of cicatricial issue on its conjunctival surface. Furthermore, it is open to the objection that in many instances the fine hairs on the skin flap come in contact with the eyeball and cause irritation, especially if the contraction of the lid continues.

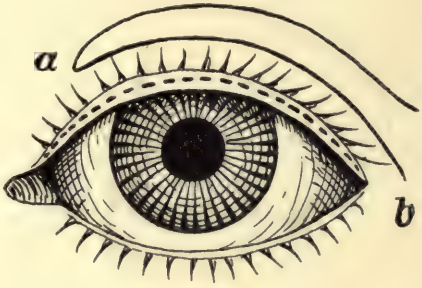


Fig. 808.

Operation of Gayet for Trichiasis.

The Flap, *a*, *b*, composed of all Tissues down to the Tarsus is dissected up and Placed in the Gap made by Splitting the Lid Along the Margin and Retracting the Cilia Border. It is held in Place by a few Sutures.

Again, it is urged as a disadvantage of this method that the skin epithelium on the new lid border is harsh and irritating to the eyeball in those cases in which the inversion of the lid margin recurs in cicatricial entropion. Hence, it is not applicable to such cases, unless at the same time the deformity of the tarsus is corrected by some plastic procedure.

To overcome the objection of the irritating effect of the skin flap on the eyeball, Van Millingen[33] was the first to propose and practise the use of mucous flaps to restore the lid border. He urged, also, as a

---

[32] Villard. Traitement du trichiasis de la paupière Supérieure par le tarso-marginoplastie. *Annales d'Oculistique*, 1904, Vol. 131, p. 439.

[33] Van Millingen. *Archives d'Ophtal.*, 1888, Vol. VIII, p. 60; also Bemerkungen über 100 Fälle von Trichiasis, operirt nach meiner Methode der sogenannten Tarso-cheiloplastik. *Centralbl. f. prak. Augenh.*, July, 1889, p. 193.

further reason for their use, the marked atrophy and contraction of the conjunctiva in cases of cicatricial entropion, such as occur in the course of trachoma, the very cases in which lid border operations are most essential, because of the rounding off of the posterior margin of the free border, from shrinking and attrition.

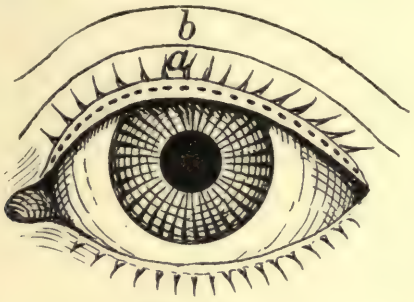


Fig. 809.

Operation of Dianoux for Entropion. First Stage.

The Lid Border is Split along the Gray Line. An Incision, 3 mm. above the Lashes, forms the Bridge, *a*. Another Bridge of Integument, *b*, is made by an Incision 3 mm. higher.

Class III, Group c. Treatment of the Free Border of the Lid by Implantation of Flaps of Mucous Membrane.

Van Millingen's Operation for Entropion.

The lid is split deeply by making an intermarginal incision along the gray line, that includes all the affected zone. To make this wound

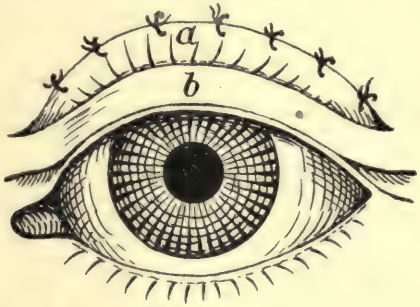


Fig. 810.

Operation of Dianoux for Entropion. Final Stage. Transposition of Flaps *a* and *b*.

gape widely, sutures are placed in the edge of the wound formed by the cilia border and then attached to the skin just beneath the eyebrow. (See figure).

With scalpel and scissors a flap of mucous membrane is cut from the inner surface of the lip, about 4 mm. wide and of sufficient length to fill the gap in the margin of the lid. This is done after the bleeding

has entirely stopped. No sutures are used to hold the mucous graft in place as it adheres to the raw surface and is usually retained. Care should be taken in cutting such a mucous graft, that it does not include the submucous fat. If such is the case, it should be trimmed off with scissors before it is inserted into the lid. The tension sutures are to remain for two or three days. Van Millingen emphasizes the importance of a liberal flap, and wide separation of the lips of the wound at the lid margin.

Gifford[34] has invented a useful lip clamp that much facilitates the excision of mucous grafts in these and similar operations.

Entropion Operation of Mutermilch.[35]

This is a useful modification of the operation of Van Millingen and is designed to insure the fixation of the mucous flap. The lid is

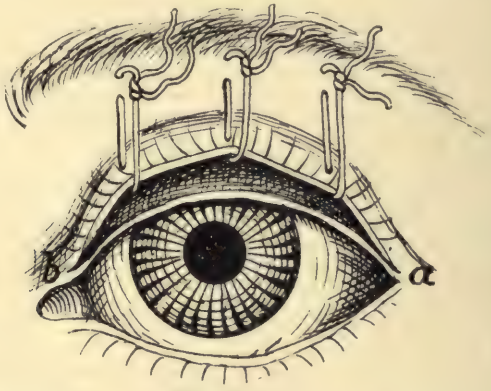


Fig. 811.

Operation of Van Millingen for Entropion.

The Wound in the Edge of the Lid, *a*, *b*, is made to gape widely with Sutures; into it is placed the Flap of Mucous Membrane.

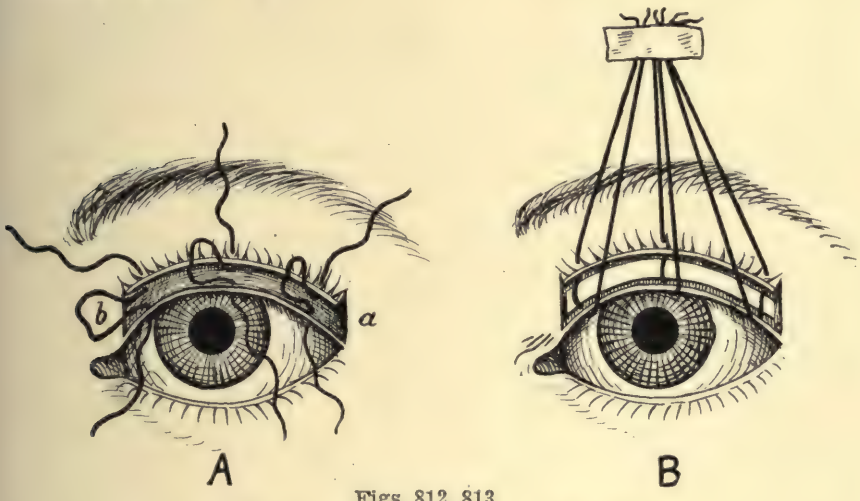
split as before described and, at each end of the cut in the margin of the lid, a vertical incision through the cilia border is made so that the extremities of the wound will be as wide as the middle. Three fine sutures are then placed through the edges of the wound in such a way that loops span the gap (Figs. 812, 813), and into these loops the strip of mucous membrane is placed. Drawing upon the upper end of each suture presses the graft into position and holds it. The sutures are then knotted and fixed to the skin above the brow by collodion or a piece of adhesive. All bleeding should have stopped before the graft

[34]Gifford. The Use of Epithelial Lip-Flaps and Half-Skin Flaps in Eye Surgery. *The Oph. Record*, Dec., 1897, p. 640.

[35]Mutermilch. De la Fixation du Lambeau Muqueux dans l'Opération Plastique du Bord Palpébral (Marginoplastie). *Annales d'Oculistique*, Vol. 125, 1901, p. 5.

is put in place. A moist aseptic dressing should be placed over the eye and the sutures need not be removed for three or four days.

Story[36] advocates the use of a mucous graft in operation for entropion, and recommends that it be secured in position in the following manner: A knot is tied in a suture a few inches from its distal end, and with a fine needle the suture is then passed through the end of the mucous flap from without inwards, so that the knot will come against the mucous surface. A similar knotted suture is then passed through the other end of the mucous flap in the same way. These sutures may be passed through the ends of the flap before it is completely detached from the lip. When it is removed it can be easily handled with the help of these sutures; and all the fat should be dissected away from its raw surface.



Figs. 812, 813.

Operation of Mutermilch for Entropion.

A. *a*, *b*, Wound in the Lid Margin made by intermarginal and lateral Incisions. Sutures are Placed in the Lips of the Wound to form Loops into which the Mucous Graft is placed.

B. Mucous Graft held in Position in the Intermarginal Wound.

The needles are then passed into the bottom of the wound at each end of the lid incision. They emerge from the skin a short distance from the cilia border. By the help of the knots which rest against the mucous surface the flap can now be drawn into position in the intermarginal gap, and the sutures can be gently tied, care being taken to keep the traction on the upper end, so that the flap will not be displaced. Story advises one to place other fine sutures along the edge of the flap.

[36] Story. The Operative Treatment of Entropion and Trichiasis. *Ophthalmic Review*, Vol. IV, p. 72.

Benson[37] also favors suturing the mucous flap in position, and prefers to leave the clamp on the lid until this is accomplished. The bleeding that follows its removal can be checked by gentle pressure for a time with a piece of moist gauze. He reports 128 cases of entropion, satisfactorily operated on by this method.

CLASS IV. CORRECTION OF DISTORTION AND INCURVING OF THE TARSUS.

One of the most important facts to consider in the treatment of trichiasis and entropion, particularly in those cases that occur as a result of trachoma, is the changes that takes place in the tarsus. In the early stages of the disease the tarsus may be thickened and enlarged from cell infiltration, but gradually this decreases as new cicatricial tissue is formed and the tarsus becomes smaller and deformed because of the contraction of the scar tissue, until in certain advanced cases it is markedly atrophied. The tarsus becomes changed in shape, its under surface is more concave and its anterior surface more convex—conditions aided by the shrinkage of the conjunctiva. This cicatricial change, if it involves the cilia border, causes distortion of the hair follicles, and so trichiasis results. As a result of the continued rubbing of the posterior margin of the free border against the eyeball, this sharp margin becomes rounded or beveled, and the free border with its oily surface, to which adheres impalpable dust, is constantly rubbing against the cornea. Even if the lashes do not touch the eyeball there is great irritation of the eye in such cases, probably because of the fine particles of dust that adhere to the edge of the lid and are rubbed against the sensitive cornea. In such cases no operation is sufficient that does not correct this incurving of the tarsus, by turning out the free border of the lid. Some operations of the class about to be considered aim to correct the deformity of the tarsus by means of tension sutures that have a fixed point of support, and in this class might be included some of the suture operations of Snellen, Boeckmann and others, although their results are rather temporary, and they are applicable more to spastic than to cicatricial entropion. A larger number, however, included in IV *(b)* accomplish the result with section or partial excision of the tarsus itself, and this method combined with tension sutures furnishes a most efficacious means of treating cicatricial entropion.

Class IV. Group a. Correction of Incurving of the Tarsus by Tension Sutures.

The operation of Hotz[38] is one of the best types of operation with

---

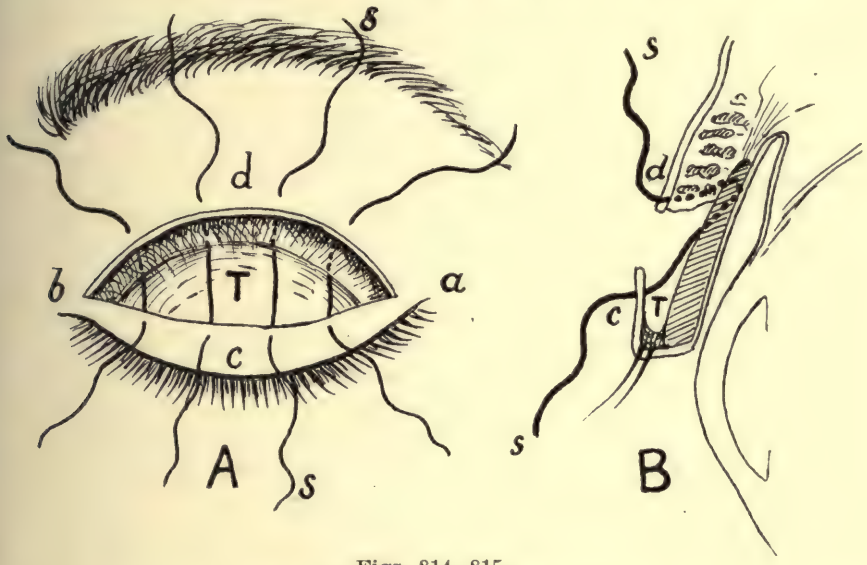
[37] Benson. *Ophthalmic Review*, Vol. VII, 1888, p. 303.

[38] Hotz. Eine neue Operation für Entropion und Trichiasis. *Archiv. f. Augenh.*, IX, 1880, p. 68; also Die Entropiumoperation am unteren Augenlide, besonders bei alten Leuten. *Klin. Monatsbl. f. Augenh.*, 1880, XVIII, p. 149.

tension sutures, and when combined with excision of a wedge shaped strip from the anterior face of the tarsus, as this author later advocated, forms one of the best operations known.

The Hotz Operation for Entropion and Trichiasis.

A lid clamp or the horn plate of Jaeger may be used, but Hotz himself used neither, making downward tension of the lid by grasping the cilia with finger and thumb and cutting down directly to the tarsus. General anesthesia may be necessary, but if the clamp is used, local anesthesia is usually sufficient. (See Fig. 814.) A curved incision, parallel to the superior border of the tarsus and a few millimeters below it (for the upper lid) is made through skin and muscle down to



Figs. 814, 815.

The Hotz Operation for Entropion.

A. Incision, *a*, *b*, being Separated, exposes the Face of the Tarsus, 1.

B. Muscle dissected from the lower Skin Flap, *c;* Sutures, *s*, pass through the Lower Skin Flap, upper edge of the Tarsus and Fascia, T, and come out through the edge of the Upper Skin Flap, *d*.

the tarsus, beginning 2 mm. above the inner angle and ending 2 mm. above the outer angle of the lid.

For the lower lid this incision is made parallel to the lid border and 3 or 4 mm. from it, because of the narrow tarsus.

The upper and lower flaps are then separated from the tarsus by blunt dissection, so that the whole lid plate is exposed to view except at the lid border, where the dissection is stopped as soon as the black points of the eyelash follicles are encountered. The next step, an important one, is to dissect off the muscle bundles from the inner side of the lower flap. This is best done, with least risk of puncturing the

skin, if the assistant seizes the skin at the edge of the flap with a fine-toothed forceps and gently stretches it at right angles to the tarsus, while the operator grasps the bundle of muscle fibers with toothed forceps and dissects them off with delicate blunt-pointed scissors. If muscle fibers overlap the upper border of the tarsus, these should also be excised. If the clamp is used, it should be removed at this stage, and the bleeding checked. Sutures, three or four, according to the size of the wound, are placed in the following manner: The lower skin flap is pierced 2 mm. from its edge, the needle is then passed through the upper border of the tarsus to emerge through the fascia attached to it, and finally comes out through the edge of the upper flap, not, however, including any muscle fibers. Passing the suture through the upper border of the tarsus is much facilitated if the operator pick up the tarsus with the point of the needle so that he can grasp the edge of it near the point that he wishes to transfix. Tying the sutures brings the lower skin flap in contact with the surface of the tarsus, where it becomes fixed, and at the same time closes the wound. Care should be taken that the lips of the wound are well coapted. The tension exerted by the lower flap, from its fixed point of support at the upper edge of the tarsus turns out the edge of the lid. A moist dressing is used, and the sutures may be removed at the end of the third or fourth day. As was previously stated, Hotz[39] in a later communication combined with his operation excision of a wedge-shaped strip of the tarsus near the lid border in extreme cases of entropion, and at the present day, the operation is frequently made with this modification.

Anagnostakis[40] was probably the first to call attention to the principle contained in the Hotz operation, viz., attaching the cilia border to the upper margin of the tarsus by means of a skin flap.

He made the incision nearer (about 3 mm.) the lid border, by which the everting effect is considerably increased, and also excised the muscle fibers from the anterior surface of the tarsus. With sutures he then united the lower skin flap to the upper border of the tarsus.

Warlomont,[41] following the same idea, made an incision parallel to the lid margin, cut away the muscle bundles and sewed the lower skin flap to the fascia above the tarsus.

Pagenstecher[42] modified the operation of Hotz by passing the sutures in such a way that the tendon of the levator was advanced, and

[39]Hotz. Die Reposition des Lidrandes bei Trichiasis des oberen Lides. *Klin. Monatsbl. f. Augenh.*, 1888, Vol. LVI,, p. 98.

[40]Anagnostakis. *Annales d'Oculistique*, 1857, XXXVIII, p. 5.

[41]Warlomont. Nouveau Procédé Opératoire pour l'Entropion et le Trichiasis de la Paupière Supérieure. *Annales d'Oculistique*, 1874, Vol. 71, p. 221.

[42]Scheffels-Pagenstecher. Ueber Vorlagerung der Levatorsehne. *Archiv. für Ophthal.*, Vol. XXXVI, 4, p. 265.

the skin of the lid was given an attachment to it. An incision, parallel to the lid border, and about 1½ mm. below the upper border of the tarsus was made, exposing the tarsus. The lower flap was then carefully separated from the tarsus and drawn down, the upper lip of the wound, with all the muscle fibers, was retracted upward so as to expose the upper margin of the tarsus and the expansion of the levator tendon.

In placing the sutures, the needle passes through the lower flap, about 1 mm. from the cilia border. The operator then seizes the tendon of the levator immediately above the superior tarsal margin with a toothed forceps and passes the needle through the upper margin of the tarsus and through the fold of tendon and fascia in the grasp of the forceps. The needle is then passed through muscle and skin of the upper lip of the wound, some distance from its edge. Sutures on either side of the middle one are then passed in the same manner. Care must be taken in tying the sutures that the edges of the wound are well coapted.

This operation of Pagenstecher not only tends to withdraw the cilia from the eye-ball, because of drawing up the lower skin flap, but also tends to raise the whole lid by shortening somewhat the tendon of the levator which is included in the suture. It is thus beneficial in correcting the slight ptosis which is so frequently present in cases of entropion from trachoma. The same may be said of the operation of Hotz, Anagnostakis and Warlomont, although to a less degree. One should remember, therefore, that, by placing the suture so as to include both the superior border of the tarsus and a fold of the tarso-orbital fascia, together with the tendon of the levator, not only the entropion will be corrected but the ptosis as well.

Class IV, Groups b and c. Correction of Distortion and Incurving of the Tarsus by Section or Partial Excision of it or a Combination of This with Sutures. Tarsoplasty.

Operations of this class mark a distinct improvement in the treatment of cicatricial entropion, especially in cases where the tarsus is thickened and incurved.

The objection that by excision of a piece of the tarsus, the lid is shortened is not valid in most cases, inasmuch as the amount usually removed, a strip at most 2 or 3 mm. wide, cannot effect shortening to any serious extent. Furthermore, in just the cases where it is indicated, there is frequently a mild degree of ptosis, so that the slight shortening that might result would be beneficial than otherwise.

The criticism that section or resection of the tarsus disturbs the Meibomian glands, or even destroys them, is hardly a reasonable objection, for in the class of cases in which this treatment is applicable,

the glands are probably to a great extent atrophied or obliterated owing to the contraction of the tarsus, as pointed out by Hotz.[43]

Entropion Operation of Burow.[44]

The upper lid is everted, and with a round, pointed scalpel an incision, about 3 mm. from the free border and parallel to it, is made from one end of the tarsus to the other. This cut extends in depth through the tarsus and the muscular layer to the skin.

Thus the cilia border falls away from the eye-ball, and in some cases Burow found the incision alone was sufficient to benefit the condition. In more severe cases of entropion, he found it necessary to remove a flap of skin from the anterior surface of the lid, the necessary amount to produce the required eversion of the lid border being determined by picking up a fold with the forceps and then incising it with scissors and scalpel. Three or more sutures then close this anterior wound, and the gap in the tarsus is left to granulate.

Gifford[45] suggested filling in the wound in the tarsus with a flap of mucous membrane taken from the lip, a procedure that he later abandoned.

Maher[46] reports success in sixty cases by a similar procedure, in which he fixes a mucous flap from the lip into the gap in the tarsus by sutures that pass through it to the outer surface of the lid.

Ammon[47] also made an incision through the tarsus and tissues of the lid from the conjunctival side.

Operation of Green for Entroplon.[48]

This operation is intended by its author for those cases of cicatricial entropion, occurring in trachoma, in which there is marked incurving and a furrow on the conjunctival side of the tarsus. It is done in three stages: 1st Stage. The upper lid is held firmly everted with the fingers. With a round-pointed scalpel an incision, parallel to and 2 mm. from the row of openings of the Meibomian glands, is made through the tarsus, in extreme cases extending from near the inner to the outer canthus. This incision (see Figure 816) is carried through the entire thickness of the tarsus, but does not extend into the muscular layer, as in the operation of Burow.

---

[43]Hotz. Die Reposition des Lidrandes bei Trichiasis des oberen Lides. *Klin. Monatsbl. f. Augenh.*, 1888, Vol. XXVI, p. 98.

[44]Burow. *Berlin Klin. Wochensehr.*, June, 1873, p. 295.

[45]Gifford. Slight Modifications of the van Millingen and of the Hotz-Anagnostakis Operations for Entropion. *Ophthalmic Record*, July, 1903, p. 327.

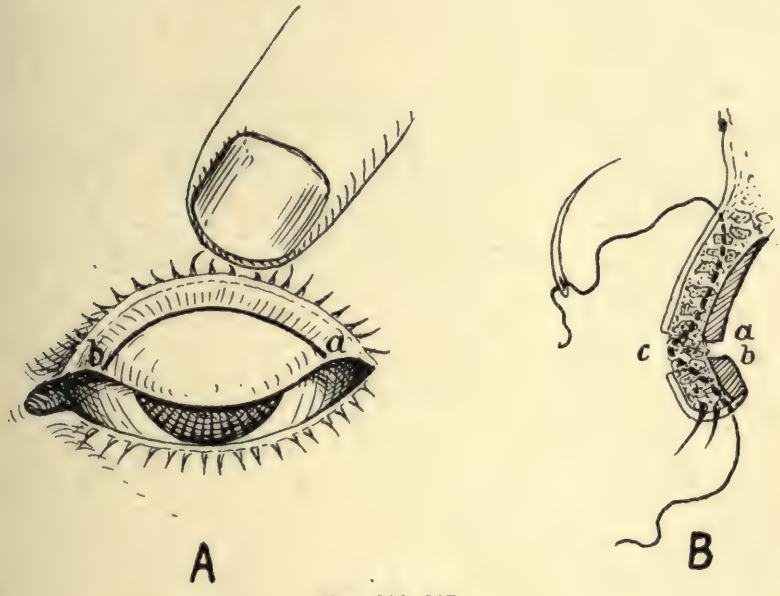
[46]Maher. An Operation for Trichiasis due to Cicatricial Entropion. *Archives of Ophthalmology*, July, 1897, p. 340.

[47]Ammon. *Encyclopédie franç. d'Optal.*, Vol. IX, p. 174.

[48]John Green. An Operation for Entropion. *Trans. Amer. Ophth. Soc.*, 1880, Vol. III, p. 167.

2nd Stage. The lid is then replaced, and a strip of skin, not exceeding 2 mm. in width, is excised from the anterior surface of the lid. The lower border of the strip should be about 1½ mm. from the line of the eye lashes, and the tissue removed should be only skin and connective tissue, leaving the muscle intact.

3rd Stage. Fine silk sutures, armed with small curved needles, are passed as follows: A needle is introduced at the edge of the lid, just behind the row of eye lashes, and brought out just within the wound in the skin. The needle is then reintroduced into the upper border of the skin wound, passed deeply backward and upward to graze the anterior face of the tarsus, and brought out 1 cm. or more above the point of entrance. Three such sutures are passed and, when tied, not only strongly evert the cilia border, but close the skin wound. The sutures are removed after a day or two. The lashes are held in the everted position by collodion applied to them until the widely gaping wound in the tarsus has nearly healed, as it does by granulation.



Figs. 816, 817.

Operation of Green for Entropion.

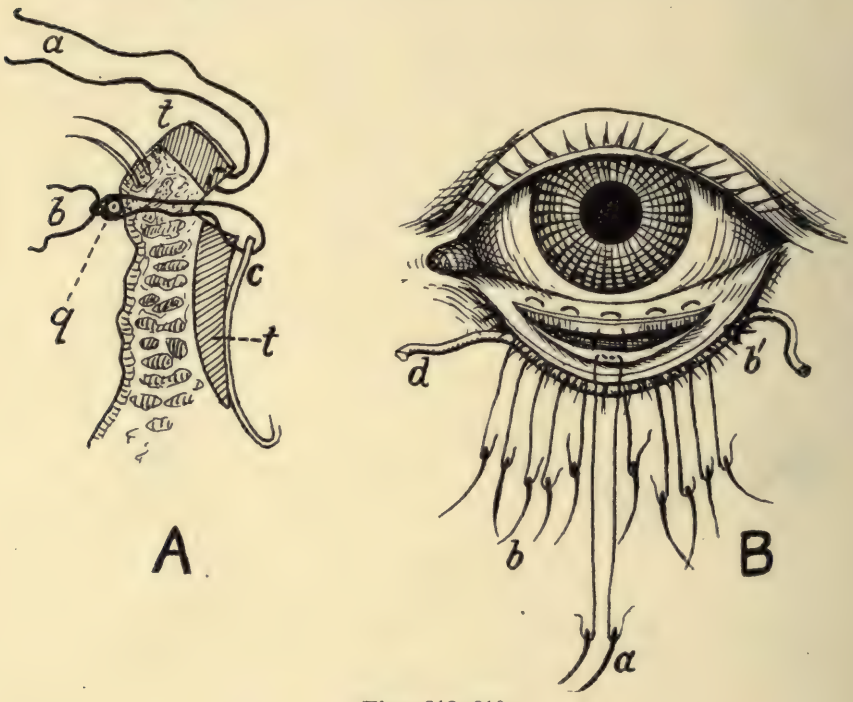
A. The Upper Lid is everted and an Incision is made through the Tarsus, 2 mm. from the lid margin; from *a* to *b*.

B. Needle with a Suture is passed behind the row of Cilia out through the Lower Border of the Skin Wound, *c*, on the anterior surface of the lid; reintroduced and passed deeply, grazing the Tarsus, to emerge 1 cm. above the Skin Wound. Tying closes the Wound and everts the Lid Border.

Ewing[49] modifies this operation in an important way, endeavoring to partially fill in the gap in the tarsus by means of conjunctiva.

Beginning at the posterior margin of the free border of the lid, he dissects back the conjunctiva from the tarsus to a distance of 4 or 5 mm. along the whole length of the lid. [This seems to be a detail of some difficulty, because of the intimate relation of the tarsus and conjunctiva].

Retracting the conjunctival flap, he makes an incision through the



Figs. 818, 819.

Operation of Ewing for Entropion.

A. Diagram illustrating placing the Sutures in the Lower Lid.

a, Traction Stitch to cause the Cut in the Tarsus to gape Widely.

b, Loop Suture passing through the Edge of the Conjuctival Flap, *c*, then through the Lip of the Tarsal Wound, the Bottom of the Tarsal Wound emerging behind the Lashes, to be tied around a Catgut Quill. *t*, Tarsus.

B. Showing the Sutures in Place on the Lower Lid. *a*, Traction Stitch. *b*, Loop Sutures through the Conjunctiva and the Tarsal Wound, to be tied over a Strand of Catgut, *d*.

tarsus exactly as in the Green operation. To aid the assistant in strongly everting the cilia border during the placing of the sutures, he intro-

[49]Ewing. *Trans. American Ophth. Soc.*, Vol. IX, p. 15; also An Improved Entropion Forceps. *Ophthal. Record*, October, 1907, p. 490, and A Knife Guard to Aid in the Tarsal Subsection, January, 1908, p. 6. See, also, *Bull. Med. Dep. Washington Univ.*, Vol. V, No. 4, Vol. VI, No. 1.

duces a temporary stitch in the cut surface of the tarsus so that traction on it will cause the tarsal wound to gape widely, as in Fig. 819. For the upper lid, seven or eight fine, double-armed loop sutures are then introduced; for the lower four or five suffice. The needles are first passed about 2 mm. apart, through the edge of the conjunctival flap which was dissected back; then through the bottom of the wound, back of the tarsus bearing the cilia, to emerge on the skin just back of the cilia. For convenience in removing the sutures and to prevent them from cutting too deeply into the skin, all the stitches are tied over a fairly large No. 12 strand of catgut placed along the edge of the lid, thus making a kind of quill suture. Tightening the sutures draws the conjunctiva into the wound and strongly everts the edge of the lid.

The eye is dressed in the usual way, and sutures may be left in

Fig. 820.

Operation of Williams for Entropion.

A Suture is passed through the Tarsus below the Incision, *a*, and emerges on the Skin of the Lid above the Eyelashes. It passes over a roll, enters the Skin and takes hold of the Tarsus at a Point above the Tarsal Incision. Tightening the Suture causes the Cut, *a*, to gape and everts the Lid Border. (After Grimsdale & Brewerton).

place for five or six days if suppuration does not occur. On the second day, the lashes are held back over the quill sutures by collodion.

Entropion Operation of Williams.[50]

The lid is everted and an incision is made through the tarsus from end to end, about 4 mm. from the lid border as in the Green operation, the cut not extending into the muscular layer.

A needle, with suture attached, is passed from the conjunctival side through the tarsus and lid below the tarsal incision, emerging from the skin just above the eye-lashes. (See Fig. 820.) It is then

[50] Williams. *Liverpool Medico-Chirurgical Journal*, 1882.

reintroduced a short distance above, to take a firm hold on the tarsus above the line of tarsal incision and withdrawn, again through the skin. Three or four such sutures are passed at equal intervals, and the loops are tied over a small roll of adhesive or tubing. Tightening the sutures, of course, everts the lid border and causes the cut in the tarsus to gape. The wound surfaces are allowed to heal by granulation.

Operation of Lagleyze.

Lagleyze,[51] of Buenos Ayres, practises an ingenious modification of the Burow operation, notable on account of the manner in which he places the tension sutures. (See Fig. 821.)

Five, or even six, needles each about 3 cm. long are threaded on one long suture and passed through the lid in the following manner:

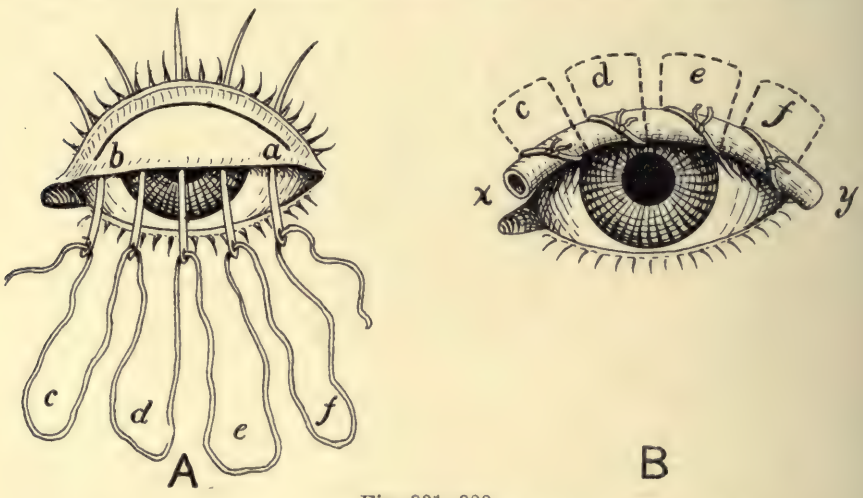


Fig. 821, 822.

Operation of Lagleyze for Entropion.

A. Upper Lid everted. Needles 3 cm. long Threaded on one Suture, *c*, *d*, *e*, *f*, Transfix the Lid, passing from the Superior Border of the Tarsus along its Anterior Face to the Cilia Border. These form a Guide for making the Incision through the Tarsus, *a*, *b*.

B. Sutures tied over the Tubing, *x*, *y*, forming Loops, *c*, *d*, *e*, *f*.

The upper lid being held strongly everted, the middle needle on the suture enters the conjunctiva at the middle point of the superior border of the tarsus, glides along the anterior face of the tarsus and emerges from the skin among the lashes, or at a point immediately behind them. It is allowed to remain, transfixing the lid, serving as a means of holding it in place until the other needles on the suture have been passed in a similar manner at equal distances apart, emerging from the skin

[51] Lagleyze. Operation de l'Entropion et du Trichiasis. *Archives d'Ophtalmologie*, Dec., 1904, p. 773.

at corresponding points near the row of cilia. Thus, if five needles are used, there are four loops of suture to catch the tarso-orbital fascia and levator tendon. While all the needles are in place, as shown in Fig. —, the operator makes an incision through the tarsus, from end to end, about 3 mm. from the lid border, and the needles serve as a guide to tell him when the incision has completely passed through the tarsus. In incomplete entropion, the length of the incision will be proportionate to the degree of the deformity, but should always extend beyond the limits of the entropion. After the incision the needles and suture are drawn through and the lid is replaced in its natural position. The thread is then cut from each needle and the ends corresponding to each loop at the superior tarsal border are tied over a small roll of gauze or tubing placed at the margin of the lid.

The sutures are allowed to remain seven or eight days, and the wound in the tarsus is allowed to heal by granulation, as in the procedures previously described.

The healing by granulation of the gaping wound in the tarsus, and the inevitable development of new cicatricial tissue on its concave surface, where scar tissue is already causing contraction, would suggest a natural objection to operations of this class. Their authors, however, and many others seem to have had excellent results from them. This objection is met by operations that aim to correct the incurving of the lid by incision or excision of a piece of the tarsus from the anterior surface.

SECTION OR PARTIAL EXCISION OF THE TARSUS FROM THE ANTERIOR SURFACE.

Streatfeild[52] was probably the first to suggest and put into practise this principle.

Streatfeild's Operation for Entropion.

An incision that extends the length of the lid is made about 2 mm. above the row of eye lashes and parallel to it. This incision passes through skin, connective tissue and muscle to the tarsus, 2 or 3 mm. above this and parallel to it. A second incision is made to the tarsus, joining the first at the extremities. The tissue between these incisions is then resected.

Two parallel incisions, about 2 mm. apart, are then made obliquely in the tarsus through its whole length, and the wedge-shaped strip so formed is excised. The incisions do not extend deep enough to divide the conjunctiva. Believing that a more permanent result can be

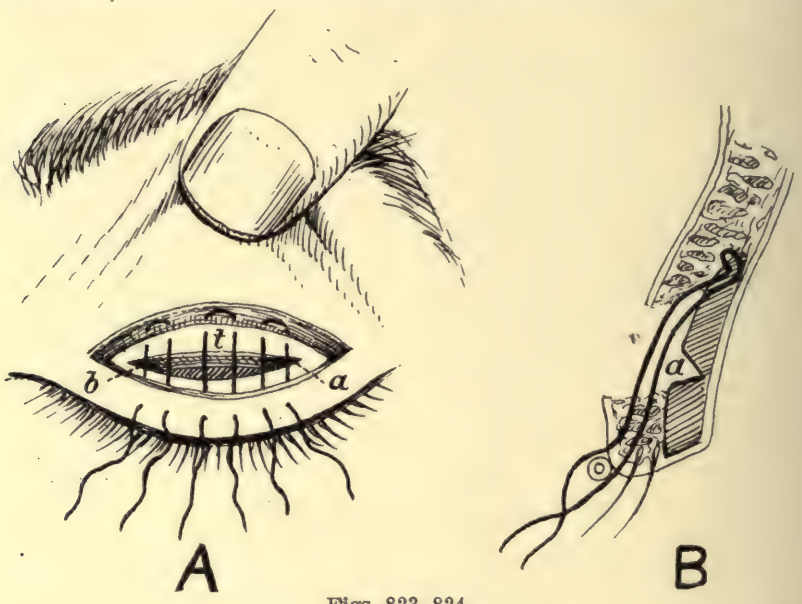
[52] Streatfeild. Entropion, Occasionally Following (Involuntarily) a Trick of Forcible Winking. *Royal Lond. Ophthal. Hosp. Reports*. Vol. II, p. 247.

obtained by a firm cicatrix, Streatfeild used no sutures to close the wound, but allowed it to heal by granulation.

The principle (excision of a wedge-shaped strip from the anterior surface of the tarsus) forms an essential feature of many of the most valuable combination forms of operation for entropion.

Snellen's Operation for Entropion.[53]

This important modification of Streatfeild's principle combines the sutures of Anagnostakis with grooving of the tarsus. The lid is held in Snellen's or Knapp's lid clamp, and an incision about 2 mm.



Figs. 823, 824.

Operation of Snellen for Entropion.

A. Incision through the Skin and Muscle to Expose the Face of the Tarsus, *t*. The Wedge-shaped strip, *a*, *b*, is cut out of this. Loop Sutures are passed from the Superior Border of the Tarsus, to emerge just above the Line of the Cilia, to be Tied around Beads or a Roll.

from the lid border, and parallel to it, is made the length of the lid through all the tissues down to the tarsal plate which, by light dissection, is then laid bare. Some of the muscle bundles may also be removed. A wedge-shaped strip of tarsus (Fig. 824), whose base corresponds to the anterior face of the tarsus, and from 1 mm. to 2 mm. in width, varying according to the degree of the incurving, is then excised from that part of the tarsus indicated by a more or less marked ridge lying over a corresponding furrow on the conjunctival side. This

[53]Snellen. Personal communication to Valude. *Encyclopédie française d'Ophtalmologie*, Vol. IX, p. 175.

strip may be excised most readily with a cataract knife, or with the two-bladed entropion knife. It includes the whole thickness of the tarsus, or nearly so, and extends from one end of it to the other, but some care should be used not to include the conjunctiva in the cut.

Three double armed sutures are passed (as shown in Fig. 823) at equal intervals as follows:—The superior border of the tarsus is seized with toothed forceps and one needle is made to transfix it; the other needle passes through the superior border about 2 mm. from the first. The needles then pass beneath the lower skin flap, grazing the tarsus, and emerge about 3 mm. apart just above the row of lashes. The sutures on either side of the middle one are passed in a similar manner, at such distances from it as to produce a symmetrical eversion of the lid border. A small glass bead is strung on the thread and the suture is tied over it; or it may be tied over a small roll of gauze or a bit of tubing. The effect of tightening the sutures is not only to evert the lid border and turn out the cilia, but also to reduce the excessive curve of the tarsus. Skin sutures may be necessary, or the sutures may be left long and secured to the forehead, which will coapt the edges of the wound fairly well. The sutures should be removed in three or four days, to prevent the beads from causing necrosis of the skin at the points of pressure.

Entropion Operation of Panas [54]

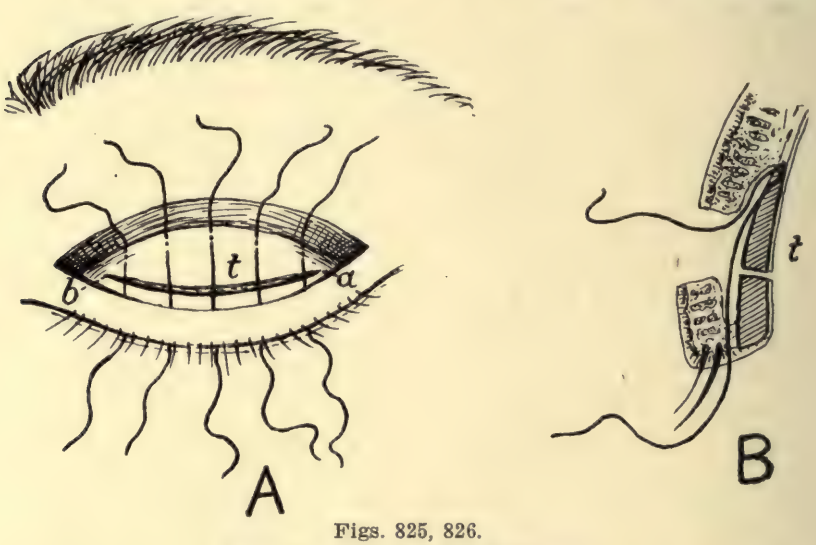
In this operation none of the tarsus is removed but it is divided completely from the anterior surface, the incision including the conjunctiva. Either a wide Snellen lid clamp, or the horn plate of Jaeger, may be used; if the latter, the assistant holds it firmly against the under surface and also draws the lid downward. An incision is then made 3 mm. from the lid border, parallel to it and extending the whole length of the lid. This incision passes through skin and muscle to the tarsus, which is then laid bare by dissecting up the upper lip of the wound until the superior border of the tarsus and the levator tendon are seen; finally separating the lower lip nearly to the lid border, not disturbing the follicles of the eye lashes. It is necessary to expose the tarsus throughout its whole extent.

The tarsus is then divided from one end to the other (Fig. 825) by an incision that includes the conjunctiva, at right angles to its surface and about 3 mm. from its free border. In cases of partial entropion a correspondingly shorter incision will suffice. Five sutures are then passed at equal intervals as follows:—The needle transfixes the tendon of the levator and superior border of the tarsus, then

[54] Panas. *Maladies des Yeux*, Vol. II, p. 153; also, *Archives d'Ophtal.*, 1882, p. 208.

passes behind the muscle of the lower flap to emerge just behind the cilia on the free border (Fig. 826). Four other sutures are passed in a similar manner; when tied they strongly evert the lashes. Care should be taken, when tying the sutures, to prevent the lower tarsal flap from riding on the upper part of the tarsus. To avoid this, and the resulting great disfigurement, Thilliez[55] suggested that the incision should not extend continuously across the tarsus, but that a narrow strip (1 mm. or 2 mm. wide) in the middle should be spared. This narrow piece of undivided tarsus would fold easily, and so would not interfere with the desired eversion of the lid.

The sutures may be left long, to be attached to the forehead



Figs. 825, 826.

Operation of Panas for Entropion.

A. The Tarsus, *t*, is Exposed and a Cut made through its entire Length from *a* to *b*, Including the Conjunctiva. Sutures are then passed through the Upper Border of the Tarsus and Emerge at the Free Border of the Lid just Behind the Lashes.

B. Diagram of a Vertical Section showing the Position of the Sutures.

above the brow with collodion or adhesive, and this coapts the edges of the skin wound so that no other sutures are required.

This operation accomplishes the bending forward of the tarsus, and holding it in this position, by the firm union of the cilia-bearing flap to a higher point on the tarsus. However, inasmuch as the conjunctiva has been divided, the incision on the conjunctival surface of the tarsus will gape when the lid is everted, and this defect will have to fill in with granulation tissue, exactly as in cases where the tarsus is divided from the conjunctival surface.

[55] Thilliez. *Encyclopédie française d'Ophtal.*, Vol. IX, p. 178.

COMBINATION OPERATIONS FOR ENTROPION.

Recognizing that in some cases it is impossible to correct severe entropion with any single operation, many surgeons of experience have combined certain features of different operations.

In most of such combinations *tarsoplasty* or *tarsotomy* figures, and an attempt is made in some of them to widen the free border of the lid by mucous or skin grafts *(marginoplasty)*.

Knapp[56] operated somewhat after the manner of Snellen by excising a wedge-shaped strip from the anterior surface of the tarsus. He then split the lid border and implanted into the gap a narrow piece of skin taken from the lid or from the hairless skin behind the ear.

Pagenstecher[57] combined his operation with canthoplasty, and an incision through the tarsus in cases of incurving.

Weeks[58] recommends a modification of the Streatfeild and Snellen operations, and combines this with grafting into the lid border a piece of mucous membrane, after the method of Van Millingen.

Gifford,[59] after doing a Hotz operation, before tying the sutures, everts the lid and makes an incision through the tarsus after the manner of Burow or Green.

Beard's Operation for Entropion.

Beard,[60] believing that in most of the severe cases of entropion resulting from trachoma an over effect at the time of the operation is essential to prevent a recurrence of the trouble, combines many of the various principles that have been mentioned. He first does a canthotomy or canthoplasty, with free division of the raphe. He next makes a deep intermarginal incision, not in the gray line between tarsus and muscle, but *splitting the tarsus itself*. This may be 3 mm. in depth and long enough to receive the ample flap of mucous membrane to be provided for it. (Fig. 827.) He then makes a cutaneous incision, and exposes the tarsus by dissecting back the flaps and removing the bundle of orbicular muscle fibres from the lower flap as in the Hotz operation. A wedge-shaped piece of tarsus is then excised, after the manner of Snellen. In passing the sutures he obtains an extreme eversion by following the principle of the Pagenstecher operation. After the suture passes through the lower skin flap (Fig. 827), it then pierces a fold of the tarso-orbital fascia and levator tendon, that has been seized by

---

[56]Knapp. *Jahresbericht f. Ophthal.*, 1895, p. 548.
[57]Pagenstecher. *Encyclopédie franç. d'Ophtal.*, Vol. IX, p. 179.
[58]Weeks. *Trans. Am. Ophthalm. Soc.*, Vol. IX, p. 18.
[59]Gifford. Slight Modifications of the Van Millingen and of the Hotz-Anagnostakis Operations for Entropion. *Ophthalmic Record*, 1903, p. 325.
[60]Beard. *Ophthalmic Surgery*, 1910, p. 264.

toothed forceps, and emerges through muscle and skin of the upper flap a considerable distance above the edge of the wound. Beard accomplishes in this way not only eversion of the lid border but correction of the slight ptosis so frequently present in these cases. Finally, the deep gap in the lid border is filled with a strip of mucous membrane, 5 or 6 mm. in width and of suitable length, cut with scissors from the inside of the lower lip. It attaches itself without sutures. This is an adaptation of the Van Millingen operation.

The eye is covered with a thin layer of cotton wet with boric acid solution, the usual dressing applied and allowed to remain for forty-eight hours; at the first change of dressing all the sutures are removed. A similar moist dressing is reapplied every day for one

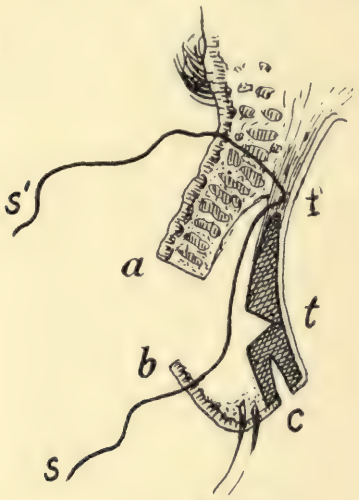


Fig. 827.

Beard's Operation for Entropion. Vertical Section.

Intermarginal Incision in the Tarsus at *c*. Skin Incision, *a*, *b*. Wedge-shaped Piece of Tarsus excised at *t*. A Suture, *s*, *s*, passes through the Lower Skin Flap, then through the Tarso-Orbital Fascia at *f*, and emerges through the Upper Flap some distance from the Cut. Mucous Membrane from the Lip is placed in the Defect in the Tarsus, *c*.

week, at the end of which time the marginal graft is secure, although even after the removal of the bandages the graft should be coated with a little vaselin for several days, to prevent desiccation. The author can testify to the pronounced and lasting effect produced by this combination of operations in the most difficult cases, and with a few differences it is the operation he usually practises on the severer cases.

As stated by Beard, cases of entropion seen in the Illinois Eye and Ear Infirmary are frequently of a pronounced character, following a long-standing trachoma that has been neglected and has received

little or no treatment. The tarsus is usually so badly affected as to require some form of tarsoplasty. The free border of the lid usually needs to be repaired by a marginoplasty, and the palpebral fissure is so much shortened as to require a canthoplasty.

Wilder's Combined Operation for Marked and Neglected Forms of Entropion.

In such cases the author prefers the following combination operation:—1st. *Canthoplasty.* In taking this step it may not be necessary to make an especially long cut, but, after the eye is cocainized and the canthus is divided with the scissors, the operator should reach into the rhomboidal wound, above and below, with a pair of fine-pointed scissors and divide freely the attachment of the orbicularis fibres to the raphé. It is to check the sphincter action of the orbicularis that a canthoplasty is made in entropion, and this may be accomplished through a *small* wound, if the attachment of the muscle to the raphé is divided, as well as through one of greater length. The long cut in the canthus has the disadvantage that the shortened conjunctiva cannot be brought out to fill the gap.

After the canthoplasty a Knapp or Snellen clamp is applied to the lid. If the palpebral fissure is not wide enough to admit one of sufficient size, a Warlomont clamp is used, the blade of which can be at first narrowed and then widened after its introduction. When the clamp has been fitted in the proper position it should be so held by an assistant as not to press upon the eyeball. The operator then injects about ten drops of 1 per cent cocaine solution beneath the skin along the line of the proposed incision and dissection. In a minute or two anesthesia will be complete, and he can continue the operation.

2nd. *The Cutaneous Incision.* This follows the line of the Snellen incision rather than that of the Hotz, and is made about 2 mm. to 3 mm. above the lid border and nearly parallel to it along the whole length of the lid. At its extremities it approaches slightly nearer the cilia border than in the middle, but the whole flap is narrower than in the Hotz operation. This incision extends through all the tissues to the tarsus and, as in the Snellen operation, the tarsus is laid bare by dissecting both flaps away from it.

3rd. *Excision of Muscular Fibres.* All the muscle fibres attached to the lower flap are carefully excised, as well as the bundle of fibers lying immediately in front of the tarsus. This neat dissection can be done much more accurately in a bloodless field, and for this reason the clamp is to be preferred. As was pointed out by Hotz, this feature of excision of muscle fibers lying next to the lid border is of great importance in correcting the blepharospasm.

4th. *Excision of a Wedge-shaped Piece of Tarsus.* This step is taken after the manner of Snellen, either with a Beer's or Graefe knife,

or with the double entropion knife of the author, the blades of which are adjustable. (See Fig. 828.)

5th. *Introduction of Sutures.* Before the sutures are placed the clamp is removed and the bleeding is checked. Three sutures are then placed as in the Hotz operation, passing them first through the lower skin flap, then through the upper margin of the tarsus (including a fold of the tarso-orbital fascia as in the Pagenstecher operation) and out through the skin *(but not through the muscle)* of the upper skin flap. By avoiding the muscle fibers when bringing the suture through the upper skin flap, these fibers are held back by the suture, so that the lower skin flap, denuded of its muscular layer, can coapt itself to the anterior face of the tarsus. Possibly a somewhat more pronounced eversion is produced by the Snellen suture (see operation of Snellen) which the author sometimes uses, but the principle is the same.

Before tying the sutures, all clots should be removed from the gap in the tarsus and from the lower skin flap, so that the lid border

Fig. 828.
Wilder's Double adjustable Entropion Knife.

will turn forward as desired and there may be nothing in the wound to prevent the perfect coaptation of the lower skin flap with the tarsus.

After tying the sutures they may, before cutting them, be used as an aid to hold the lid while the operator is making the intermarginal incision, if it is thought best to use a marginal graft.

6th. *Intermarginal graft.* This may be of mucous membrane from the lip or of skin taken from behind the ear. The lid margin is divided behind the row of cilia, and into the gaping wound is placed the narrow graft, not more than 1½ or 2 mm. in width. This graft may be cut with a Graefe knife, or with the double entropion knife referred to. The sutures are then cut off and a moist dressing is applied, to be changed each day. At the end of the third or fourth day the sutures may be removed, but the dressing should be continued for a week.

CONCLUSIONS.

The difficulty of correcting trichiasis and entropion, and securing a permanent good result, is indicated by the great number of operations that have been devised for their treatment. An attempt has been made

to describe the typical operations, with their most noteworthy modifications and the principles on which they are based. It would be impossible in the space of this chapter to give in detail *all* the modifications that have been suggested, but enough have been presented to show that no one type of operation is suitable for every case. The experienced operator will select that method which, in his judgment, is most applicable to the case in hand, or will modify it to meet the exigencies of such a case. Bearing in mind the main principles underlying the typical operations, he will be able to combine them, if necessary, to produce the desired result.

If the entropion is of the spastic variety it may be relieved by one of the simple suture operations, or at worst by that of Hotz.

Many of the operations described produce their greatest effect on the middle of the lid, so that if the trichiasis is partial and affects particularly the inner or outer angles, an operation such as that of Spencer Watson for partial entropion would be applicable.

If trichiasis exists and the tarsus is still of normal contour some operation described under Class II would be suitable, especially if combined with marginoplasty.

In severer cases, where the tarsus also is deformed or incurved, nothing short of tarsoplasty of some kind, combined with other methods, will suffice to effect a cure.

PTOSIS.

Ptosis is a drooping of the upper eyelid, which may be partial or complete. The condition may be either congenital or acquired.

Congenital Ptosis.

This anomaly is sometimes hereditary. It usually affects both upper eyelids and is frequently associated with other defects, such as weakness of the superior rectus, squint, microphthalmus or epicanthus. In congenital ptosis there may be defective development or complete absence of the levator muscle and, as mentioned above, this may be associated with an inability to look upward, owing to defective innervation, imperfect development or absence of the superior rectus.

Cases of congenital, mostly unilateral, ptosis have been observed in which the lid cannot be elevated in the natural manner, but as soon as the patient opens the mouth or moves the lower jaw to one side or the other, the lid is raised completely, and remains so until the action of the jaw is discontinued.

Acquired Ptosis.

This condition is due either to some injury of the levator or to a lesion of the nerve or nerve center supplying it. As the levator pal-

pebræ is supplied by a branch of the third nerve, ptosis frequently accompanies paralysis of other ocular muscles supplied by this nerve. The lesion may be either in the trunk of the nerve, in its nucleus or, possibly, in the cortex of the cerebrum.

A slowly-appearing, progressive, partial ptosis is sometimes observed in women about the time of menopause, or in elderly people, that is probably due to a form of atrophy of the levator.

Pseudo-Ptosis.

Drooping of the lid occasioned by swelling from oedema, tumors and elephantiasis should not be classed with cases of genuine ptosis. So, too, the slight drooping of the lid so frequently seen in trachoma is due more to the additional weight of the lid, combined probably with paresis of the muscle of Müller.

The condition known as *ptosis adiposa* is the result of a relaxed skin which hangs down like a fold over the free border of the lid, and becomes more noticeable when the lid is drawn upward. This is due to the lack of rigidity of the fascial fibers of the levator tendon, that pass forward between the bundles of the orbicularis muscle to be attached to the skin of the eyelid.

All of these forms should be classed under the head of pseudo-ptosis, in contradistinction to true ptosis, operations for which are here to be considered.

In cases of complete ptosis, the cornea is covered and vision is impossible unless the lid is raised either with the hand or with some mechanical appliance such as a spring attached to a spectacle frame.

In double partial ptosis, the patient's head takes a characteristic backward pose to enable him to look under the lid border, and at the same time the forehead is wrinkled and the eyebrows raised in an attempt to aid the weakened levator by the action of the frontalis.

Treatment of the Various Forms of Ptosis.

The treatment of ptosis will depend upon the nature of the trouble. Some cases of *acquired ptosis* may be relieved by non-operative treatment.

Frequently paralytic ptosis has a syphilitic origin, and may be remedied by appropriate anti-syphilitic measures, if treatment is begun in time. If this is unsuccessful, the advisability of an operation will be determined by the degree of the ptosis, and whether or not it is associated with paralysis of some of the other ocular muscles. If the latter is the case, it may be better to let the drooping lid remain rather than to raise it by an operation and so subject the patient to an annoying diplopia.

Electrical treatment, massage, and other measures should be tried before resorting to operation in such cases.

Numerous mechanical devices have been used at various times to hold up the drooping lid, and in late years Goldzieher,[61] Kauffmann[62] and Meyer[63] have revived this form of treatment. The support for the lid is generally attached to some form of spectacle frame, adjusted to suit the individual case. Such expedients are merely temporary, and need only be alluded to in this connection.

In traumatic ptosis due to division of the levator or its tendon from a wound of the eyelid, the divided ends of the muscle or tendon should be carefully searched for and reunited by catgut sutures, before the wound in the lid is closed.

In the *congenital* forms, the question of advisability of an operation will depend upon:

1st. The degree of the deformity.

2nd. Whether bilateral or unilateral.

3rd. Condition of the sight and of the ocular muscles of the affected eye.

Naturally, if the ptosis (of one lid or both) is slight and is not enough to interfere with vision of the eye, the only reason for an operation would be a cosmetic one.

The same might be said of complete, unilateral ptosis of a markedly amblyopic eye, or of one whose extrinsic muscles are so affected as to prevent binocular single vision if the lid were raised.

The question of the best method of operative procedure in cases of ptosis, in which operation is deemed advisable, will depend largely upon the degree of power still remaining in the *levator palpebræ*. If this muscle still retains some degree of power in raising the lid this may be increased by so changing its point of insertion in the lid that it may act to better advantage. If, however, this muscle is powerless, as it frequently is in complete congenital ptosis and in some of the paralytic cases, recourse will be necessary to those forms of operation which aim to raise the lid by substituting for the levator the action of other muscles. It is, therefore, extremely important to determine not only the exact nature of the deformity, but the relative strength of the levator. The former can usually be done by the history of the trouble and the degree of it. The latter can be easily determined, as suggested by Grimsdale and Brewerton,[64] by firmly depressing the eyebrow of the affected side so as to control the power of the frontalis

---

[61]Goldzieher. Einfachtes Verfahren gegen Ptosis und Entropium spasticum. *Centrabl. f. prak. Augenheilk.*, 1890, p. 34.

[62]Kauffman. Eine Ptosis Brille. *Centralbl. f. prak. Augenheilk.*, März, 1893.

[63]Meyer. Therapie der Ptosis. *Archiv f. Augenheilk.*, 1893, Vol. XXVI, 2, p. 153.

[64]Grimsdale & Brewerton. *A Text Book of Ophthalmic Operations*, 1907, p. 53.

muscle upon the lid, and then noting, when the patient is asked to open the eye, whether there is any motion of the lid upward. If so, it is evidence that the levator is still active.

The numerous operations that have been devised for ptosis is an evidence of the difficulty in satisfactorily correcting this condition. In considering these various methods the following classification has been adopted, partly because it indicates somewhat the chronological order in which the various procedures were developed, and also presents first for description those which aim to correct the severer forms, viz.: complete ptosis, with entire or almost entire loss of power of the *levator palpebræ*. It will be seen that some of the operations combine operative principles in two or more groups. The classification follows very closely that of Grimsdale and Brewerton.

OPERATIONS FOR PTOSIS.

Class I. Shortening the Lid by Excision of the Skin.

(Method of)	(Modification by)
Arabian surgeons;	Hunt.
Scarpa;	
Graefe.	

Class II. Substituting the Action of the Frontalis Muscle for That of the Levator Palpebræ.

Group *a*. By means of sutures.

(Method of)	(Modification by)
Dransart;	Dehenne;
Pagenstecher.	Gayet;
	Birnbacher;
	Mules;
	Worth;
	Harman;
	de Wecker;
	Landolt;
	Hess.

Group *b*. By flaps of skin.

(Method of)	(Modification by)
Panas.	Tansley;
	Allport;
	Grimsdale;
	Rollet;
	Darier.

Group *c*. By attaching a flap of the frontalis muscle to the lid.

(Method of)
Fergus.

Group *d*. By attaching the tendon of the levator to the frontalis.

(Method of)	(Modification by)
Angelucci.	Sourdille.

Class III. Advancement of the Point of Insertion of the Levator Palpebræ.

Group *a*. By partial excision of the tarsus and levator tendon.

(Method of)
Bowman.

Group *b*. By folding the tendon.

(Method of)	(Modification by)
Eversbusch.	Snellen;
	Wolff;
	Lapersonne;
	Elschnig.

Group *c*. By excision of a strip of the tarsus.

(Method of)	(Modification by)
Bowman;	Nicati;
de Grandmont.	Boucheron;
	Gruening;
	Theobald;
	Fergus;
	Mayou.

Combination of the Principles of Classes II and III.

(Method of)
Beard;
Wilder.

Class IV. Substituting for the Action of the Levator That of the Superior Rectus.

(Method of)	(Modification of)
Motais;	Shoemaker;
Parinaud.	Wilder.

CLASS I. SHORTENING THE LID BY EXCISION OF THE SKIN.

According to Valude[65] the ancient Arabian operators treated ptosis by excising a piece of skin from the lid sufficiently large to effect the necessary shortening. Scarpa followed the same practice, but observed that if the skin were removed from the lid near the eyebrow the effect was even more pronounced.

Hunt[66] recognized the principle that not only is the levator palpebræ used in raising the lid, but part of the frontalis as well. He states that "it is almost impossible to draw the eyebrow upward when

[65] Valude. *Encyclopédie Française d'Ophtal.*, Vol. IX, p. 141.
[66] Hunt. *London Med. Gazette*, Vol. VII, 1830, p. 361.

the eye is kept completely closed, and equally difficult to depress the eyebrow while the eye remains wide open," and that "the anterior fibers of the occipito-frontalis inserted into the superciliary integument prevent the levator from drawing the eyelid too far backward."

Hunt's Operation.

A curved incision just below the line of hairs of the eyebrow is made through the skin, extending from a point over the inner angle of the lids to one the same distance above the outer angle. This incision is joined at either end by one made parallel to the lid margin and at a sufficient distance above it to obtain the desired degree of elevation of the lid. The skin between these incisions is then dissected away, leaving the fibers of the orbicularis intact, and the edges of the wound are united with sutures. The effect is to bring the skin of the lid in contact with that part of the skin of the brow on which the frontalis acts. The operation is applicable only to those cases in which the levator is paralyzed.

This is, in effect, the principle upon which are based the operations to be described under Class II, and naturally leads up to them. As will be seen later, Tansley modified this operation. Graefe[67] made an incision the length of the lid, through the skin and about 4 or 5 mm. from the free border. Separating the lips of the wound, he then excised a strip of the orbicularis, 5 mm. wide, down to the tarsus and levator. If there were a redundancy of skin, he also excised a narrow strip of it, after the manner of the ancient surgeons, and then brought the lips of the wound together with sutures which he passed through the skin and the edges of the divided muscle. He thus aimed to get a subcutaneous shortening of the lid and a weakening of the orbicularis, to offset the weakened levator.

All of these methods naturally fell into disuse because the shortening of the lid prevented proper closure, and ulceration of the cornea from lagophthalmus so frequently followed.

CLASS II. SUBSTITUTING THE ACTION OF THE FRONTALIS MUSCLE FOR THAT OF THE LEVATOR PALPEBRAE.

Group *a*. By means of sutures.

Dransart[68] was probably the first to apply by means of sutures the principle first enunciated by Hunt, but the procedure of Pagenstecher, next to be described, was proposed nearly at the same time.

Operation of Dransart.

An incision in the skin of the upper lid is made along the length of the superior border of the tarsus exposing it. The skin of the upper

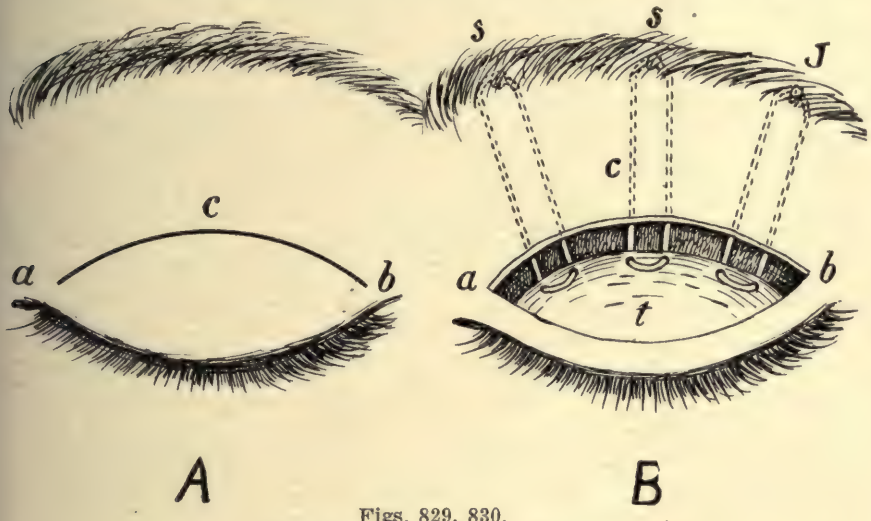
[67] Graefe. Operation der Ptosis. *Archiv f. Ophthal.*, Vol. IX, 2, p. 57.

[68] Dransart. Blepharoptose operé par un procédé special à l'auteur. *Annales d'Oculistique*, 1880, Vol. 84, p. 88.

flap is next separated, by dissecting up to the muscle overlying the eyebrow, so as to expose the upper part of the orbicularis. Then a loop-suture of catgut, armed at each end with a needle, is passed through the middle portion of the superior border of the tarsus, the needles passing from the superficial to the deep surface and emerging again immediately above the tarsal border.

The needles then pass through the cellular tissue and muscle under the eyebrow.

In the same manner a similar suture is passed, at a distance of 6 mm. or 8 mm., on either side of the middle one. (See the figures.)



Figs. 829, 830.

Dransart's Operation for Ptosis.

A. Incision, *a*, *b*, made along the line of the superior border of the tarsus, exposing it. Flap *c*, of skin, is then separated from the muscle up to the eyebrow.

B. Loop-sutures, s. *s*, J. of catgut pass through the upper border of the tarsus, *t*; then under the skin flap, *c*, and are attached to the muscular tissue under the eyebrow.

The sutures are tightened sufficiently to elevate the lid, and the ends are cut short near the knot. After the bleeding has ceased the flap of skin is replaced and the wound united with superficial sutures.

As a result of the operation, there are formed along the line of the buried sutures, strands of connective tissue that connect the frontalis muscle directly with the lid and thus assist in raising it.

Operation of Pagenstecher.[69]

This operation also aims to establish a connection of the frontalis with the lid by means of sutures and bands of cicatricial tissue.

---

[69]Pagenstecher. Eine neue Operation zur Heilung der Ptosis. *Bericht d. Internat. Congress zu London*, 1881.

Two double-armed sutures of silk are passed in the following manner: One needle enters the skin of the lid at a point 2 mm. above the free border and 7 mm. or 8 mm. from the angle of the lid, *a*. It traverses a course beneath the skin to emerge just above the eyebrow at *b*. The other needle, on the same suture, enters the skin at the point of puncture of the first, *a*, and passes under the skin in a line parallel to the free border, to emerge 3 mm. distant at a point, *c*. It is then reinstated at the same point as it emerged, to traverse a course beneath the skin parallel to that of the first and to emerge above the brow at a point, *d*, 3 mm. from the first. There is thus placed a subcutaneous loop. See the illustration.

In a similar manner the second suture is passed about 8 mm. from the other angle of the lids. The two sutures should not be exactly vertical, but should be somewhat farther apart above the brow than at the lid border. The sutures are then tightened sufficiently to raise the lid, and are tied with bow-knots over a roll of gauze or a piece of tubing.

All these steps should be taken with the usual antiseptic precautions. The sutures may be gradually tightened, until they have cut their way out. If suppuration occur they should be removed.

The effect is frequently temporary, because the strands of new connective tissue along the track of the sutures often relax and let the lid droop again.

There have been a number of interesting modifications of these methods of Dransart and Pagenstecher for uniting the lid to the frontalis by means of sutures. Some operators have used silk, some catgut, others platinum or gold wire.

Dehenne[70] advises the use of more resistant sutures than ordinary catgut, and therefore employs catgut sutures hardened in naphthol, which he introduces after the manner of Dransart. He also makes use of platinum sutures.

Gayet[71] uses platinum wires which he introduces after the manner of Dransart. When they are in place, before tying them, he attaches the ends of the loop to a battery capable of making them red-hot, and thus slightly cauterizes the track of the wires, to insure the development of cicatricial strands.

Birnbacher[72] makes an incision through the skin of the lid cor-

---

[70]Dehenne. *Bulletins et Mem. de la Soc. française d'Ophtal.*, Vol. IX, 1891, p. 83.

[71]Gayet. *Bulletins et Mem. de la Soc. française d'Ophtal.*, Vol. IX, 1891, p. 83.

[72]Birnbacher. Nouveau procédé opératoire applicable au ptosis congenital. *Archiv d'Ophtal.*, Vol. XII, p. 717.

responding to the superior border of the tarsus, which is exposed in nearly its whole length.

Three double-armed sutures of silk are passed through the superior border of the tarsus, 7 mm. apart. They are then passed subcutaneously, to emerge above the eyebrow, where each loop is held around a roll of gauze or a piece of tubing. They are left in place for at least three weeks. This operation, instead of being a new procedure, is almost identical with that of Dransart, with the slight difference that the sutures are tied above the brow, where they can be removed instead of being buried.

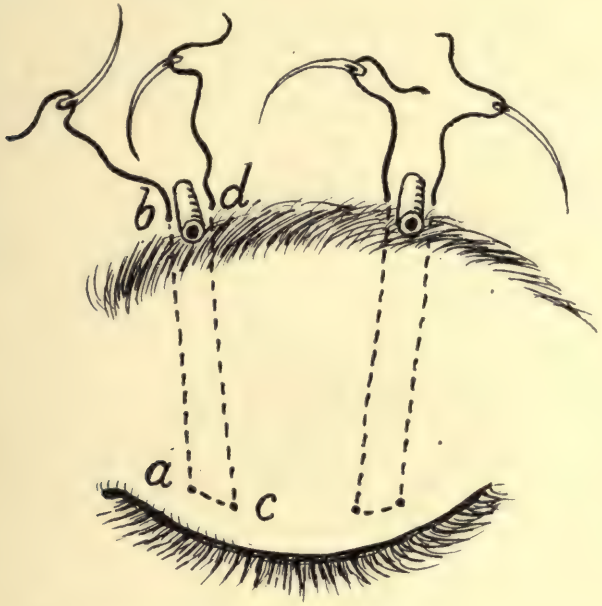


Fig. 831.

Pagenstecher's Operation for Ptosis.

The first needle enters the skin at *a* and passes subcutaneously to *b*. The second needle, on the same suture, enters at the same point, *a*, and passes beneath the skin to emerge at *c*; re-enters at *c*, and passes beneath the skin to *d*, in a course parallel to the first.

The following operation of Mules is in some respects similar to that of Pagenstecher.

Mules' Operation for Ptosis.[73]

An incision is made in the middle of the lid margin, about 6 or 7 mm. in length, just anterior to the row of openings of the Meibomian glands. This incision need not be more than 3 mm. in depth. A small incision, 3 or 4 mm. in length, is made a few millimeters above the eyebrow in a line vertical with the incision in the lid margin. A loop

of gold wire is then passed in the following manner:—A special needle, with the eye near the end, is passed from the nasal end of the small incision above the eyebrow beneath the skin, to emerge at the inner end of the intermarginal incision *b*. The gold wire is threaded into the needle and drawn back with it so as to emerge at *a*. The needle is again passed through the other end of the superciliary incision, *c*, to come out at the temporal end of the intermarginal incision, *d*, where it is again threaded with the other end of the wire, which is drawn up beneath the skin of the lid. There is thus formed a loop of wire which sinks into the margin of the lid. The ends are then drawn up slightly more than is necessary to produce the desired elevation of the lid, and are twisted over a probe, which is laid across the small skin

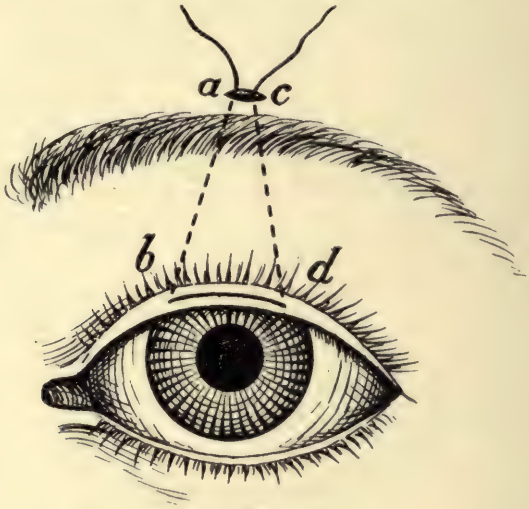


Fig. 832.

Mules' Operation for Ptosis.

a, *c*, a short incision, 3mm. in length, above the eyebrow; *b*, *d*, incision 7mm. in length, in the margin of the lid. An inserted gold wire emerges at *a*, *c*, and forms the loop, *b*, *d*, buried at the lid margin.

incision above the brow. The ends are then cut short and the probe withdrawn, when the loop sinks into the little wound, which may then be closed, if necessary, with a suture. There is thus produced a loop that acts as a permanent tendon.

The advantages urged for this method are its simplicity, the absence of scar and the short time of convalescence. The contention that the metallic foreign substance is liable to be extruded because of the motion of the lids is met by the statement of Grimsdale and Brew-

[73]Mules. *Trans. of the Eighth Internat. Congress of Ophthalmology*, p. 57. Also *Trans. Ophth. Soc., U. K.*, Vol. XVIII, p. 227.

erton[74] that they have not known this to take place when the wire is properly introduced and firmly enough twisted, with the ends sufficiently buried in the little wound.

Worth's Operation for Ptosis.

Worth[75] modifies the operation of Mules by using kangaroo tendon specially prepared by splitting and scraping it (to make it smooth), then soaking it in ether (to remove the grease) and, finally, in a solution of biniodid of mercury. It is lubricated with sterilized vaseline.

In passing it subcutaneously it takes a long course to avoid making a knot in the suture.

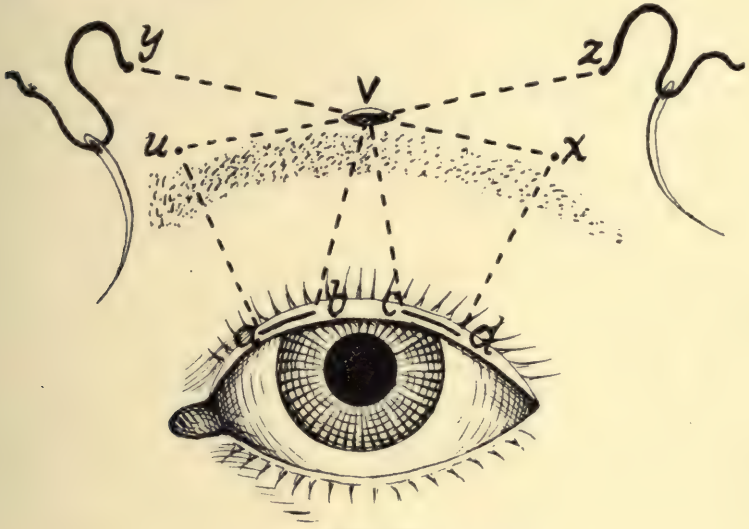


Fig. 833.

Worth's Operation for Ptosis.

a, *b*, and *c*, *d*, are intermarginal incisions in the gray line, 4 mm. in length, 2 mm. in depth; *v*, a small puncture-incision above the shaved brow. The first needle passes from *b* to *v*, is reinserted at *v*, and emerges at *c*; then inserted at *d*, to emerge at *x*, and, finally, at *y*. The other needle passes from *a* to *u*, and finally crosses to *z*. Traction on the sutures at *u* and *x*, elevates the lid to the required extent, and the sutures are fixed by passing them on to *y* and *z*.

The eyebrow is shaved. Two small incisions, about 4 mm. in length, are made in the gray line of the lid, about 3 mm. on either side of the middle of the lid margin, *a*, *b*, and *c*, *d*, as shown in the figure. The suture is threaded on two firm Hagedorn needles. The first needle enters the end of the intermarginal incision, *b*, and passes

[74]Grimsdale and Brewerton. *A Textbook of Ophthalmic Operations*, p. 64.

[75]Worth. An Operation for the Relief of Congenital Ptosis. *The Ophthalmoscope*, Vol. I, p. 13.

subcutaneously to the little incision above the brow at v. It is reintroduced here and passes beneath the skin of the lid, to emerge at the inner end of the other intermarginal incision at *C*. This makes a loop, *b, v, c.*

The first needle now enters the outer end of the marginal incision, *d,* and passes subcutaneously to *x,* while the needle on the other end of the suture enters at the outer end of the other marginal incision at *a,* and emerges at *u,* the course of these diverging slightly.

By slight traction on the loops at *a, b,* and *c, d,* the point of attachment at *v* is sunk into the tissues, and then by traction on the suture at *u* and *x* the loops are drawn into the intermarginal incisions and the lid is raised to the extent desired. Finally, the needles are reintroduced at their points of emergence, *u,* and *x,* and are passed subcutaneously across the eyebrow, emerging at *y* and *z* respectively, where they are cut short that they may retract beneath the skin. No scar is left and the results obtained by the method are said to be good.

Harman's Operation.

Harman,[76] instead of the kangaroo tendon, which is difficult to prepare, used a delicate gold chain of the kind known as "wove chain", strong enough to sustain a weight of 15 pounds. A bayonet-shaped, 4-inch, abdominal needle was used, and either soldered to the chain or attached to it with a silk thread. It was passed in the following manner, indicated in the diagram. (See Fig. 834.)

The needle is inserted into the skin at a point near and above the nasal end of the eyebrow, *a.* It then passes beneath the skin and muscle to *b,* external to the middle of the brow, where it emerges. About 6 inches of the chain is drawn through—enough to complete the suture. The needle is reintroduced at the point of emergence, *b,* and follows a vertical path beneath the skin to a point, *c,* a few millimeters above the lid margin, where it is again brought out, and the chain drawn through. It is reinserted at this point of exit, and passed to the point, *d,* in a course parallel to the lid border; the needle in this course passing through the tarsus. From the point, *d,* the chain passes upward in a course parallel to *b, c,* to emerge at *e,* above the eyebrow, where it is passed to *f,* a point above the temporal end of the eyebrow. Traction on the chain elevates the lid to the required degree, and the ends of the chain are then cut off and left buried in the tissues. Granulation tissue develops in the meshes of the chain and it becomes encapsulated. Grimsdale and Brewerton[77] state that

[76]Harman. An Improved Operation for the Relief of Ptosis Palpebrae. *The Ophthalmoscope,* Vol. 1, p. 137. Also, An Improved Operation for the Relief of Ptosis. *Brit. Med. Journal,* Sept. 26, 1903, p. 736.

[77]Grimsdale and Brewerton. *A Textbook of Ophthalmic Operations,* p. 68.

this method is but little more difficult than the Mules' because the marginal incision is avoided. They point out the necessity for particular attention to antiseptic details, to prevent infection of the lid tissues by the chain.

de Wecker[78] combined the principles of the Graefe and Pagenstecher operations in the following manner:

de Wecker's Operation for Ptosis.

An oval piece of skin with the bundle of orbicular fibers corresponding to it is excised by making an incision 4 mm. or 5 mm. from the lid border along the length of the lid, *a, b,* and joining this at each end with a curved incision, *c,* parallel to the superior border of the tarsus. (See the illustrations.)

Two loop sutures are then passed at a suitable distance apart,

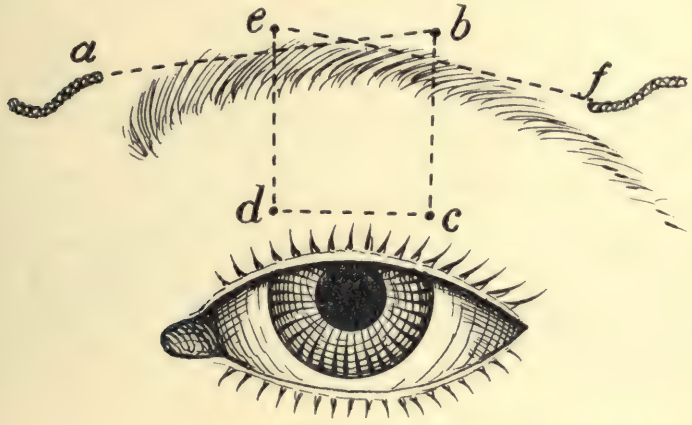


Fig. 834.

Harman's Operation for Ptosis.

"Wove chain" suture is passed subcutaneously from *a* to *b*. The needle is re-inserted at *b*, passes to *c*, then to *d*, and *e*, and finally emerges at *f*. In its course from *c* to *d*, it passes through the anterior part of the tarsus. (After Grimsdale and Brewerton.)

from the lower skin flap of the eyelid to points above the eyebrow. Double armed sutures are then employed in the following manner: One needle of the suture is inserted through the skin of the lower flap, to emerge in the wound; it is then reinserted beneath the skin of the upper lip of the wound, to emerge above the eyebrow. The other needle, following a parallel course after being introduced about 4 mm. or 5 mm. from the first, in the lower skin flap, leaves a loop on the skin above the lid border. (In this respect it differs from the

[78]Masselon and de Wecker. Une nouvelle opération du ptosis. *Annales d'Oculist.*, 1882, Vol. LXXXIII, p. 29. Also, Une opération du ptosis. *Archives d'Ophtal.*, Vol. XIII, p. 426.

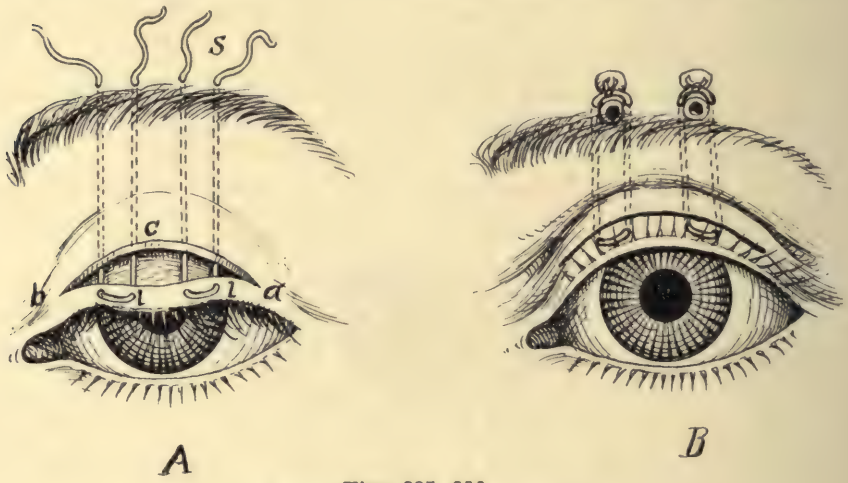
Pagenstecher suture, the loop of which is buried.) After making the necessary traction to elevate the lid, the sutures are tied over a roll of gauze or tubing.

As in other operations of this variety, the sutures may be first tied with a temporary bow-knot, so that the tension on the lid may be increased or diminished after a few days, as required, when the sutures can be more securely tied.

Such an operation is applicable to those cases in which there is considerable redundancy of the lid skin.

Operation of Hess.[79]

After shaving the eyebrow, an incision is made along its whole length through the skin only . (See the figure.) The lower skin flap is then separated from the muscle layer by dissection, nearly to the



Figs. 835, 836.

de Wecker's Operation for Ptosis.

The incision, *a*, *b*, parallel to lid border and 4 mm. above it, is joined by the curved incision, *a*, *c*, *b*. An oval piece of skin and the corresponding muscle are excised. Double-armed sutures pass through the lower skin flap, forming loops, *l;* then across the wound to enter the subcutaneous tissue of the upper flap, and emerge above the eyebrow. Traction on the sutures elevates the lid and closes the wound.

lid border. After this is accomplished the surgeon can estimate the amount of elevation to be produced and the points where sutures should be placed by seizing the skin flap from the inner side with forceps and noting the effect. Three double-armed loop sutures are then introduced, so that the loop will be on the skin surface at places determined by traction with the forceps mentioned. The sutures are

[79]Hess. Eine Operationsmethode gegen Ptosis. *Archiv f. Augenheilk.*, 1893, Vol. XXVIII, p. 22.

then passed beneath the brow, to emerge 1 cm. or more above it, where they are tied around rolls or tubing. The skin wound is closed with sutures. The main sutures are allowed to remain for two weeks. Traction on the sutures raises the lid, and the skin is folded on itself in the position of the normal sulcus.

The scar is concealed when the hair of the eyebrow grows again.

Landolt's Operation for Ptosis.

Landolt[80] modifies the procedure of de Wecker in the following manner:

After the incision is made, 4 mm. above the free border of the lid and parallel to it, the superior flap of skin is separated to the level of the orbital margin, without excising any of the skin. Three loop

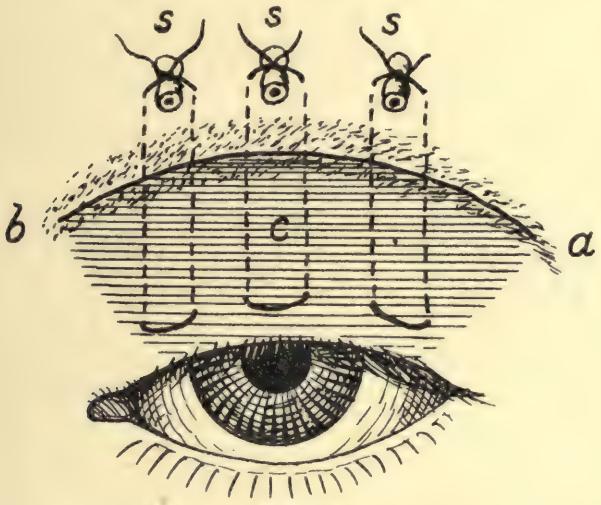


Fig. 837.

Hess Operation for Ptosis.

An incision, *a*, *b*, is made along the line of the previously shaved brow. A skin flap, *c*, is then dissected away from the muscle fibers nearly to the lid border, as indicated by the shading. Loop sutures are then placed in the manner indicated, the loops being on the skin surface.

sutures, double armed, are then passed through the lower lip of the wound, the needles on each suture entering about 6 mm. apart, and taking hold of the tarsus. They are then passed beneath the separated skin flap, to emerge above the eyebrow, where, after sufficiently elevating the lid by traction, they are tied with a bow-knot over a piece of tubing or gauze. By traction on the sutures, the border of the lid is drawn up under the superior lip of the incision. Immediately after

[80]Landolt. Une modification de l'opération du ptosis. *Archives d'Ophtal.*, 1897, Vol. XVII, p. 1.

the operation the raw edge forms the border of the lid; but, according to Landolt, this edge usually retracts to its proper position. Should it fail to do so after some days, when cicatrization of the deeper layer is sufficiently advanced to show the effect produced on the ptosis, a similar row of loop sutures is passed through this skin flap, these sutures also emerging above the eyebrow. Landolt prefers treating this overhanging skin flap by a subsequent operation, because, if the effect of the first be insufficient, it may be increased by the second row of sutures; if the effect of the first operation be too great, it is diminished by loosening some of the cicatricial bands at the same time that the second sutures close the skin wound.

Class II, Group b. Substituting the Action of the Frontalis Muscle for that of the Levator by Means of Flaps of Skin.

Operations of this class are especially applicable to cases of partial or complete ptosis, in which it can be demonstrated that the levator muscle possesses very little or no power to raise the lid, either from a paralysis that has resisted treatment or from imperfect development or absence of the muscle.

Operation of Panas[81] for Ptosis.

In this well-known operation, a flap of skin from the anterior surface of the eyelid is attached to the frontalis muscle. See Fig. 838.

The eyebrow is shaved. The lid is drawn down over a Jaeger plate, and a horizontal incision, *a, b,* is made from nearly one commissure to the other, interrupted in the middle, for 8 mm. or 10 mm., at *c, d.* This incision follows the fold of separation of the tarsal and orbital portions of the lid. From the inner ends, *c, d,* of the interrupted incision, two vertical, parallel incisions are made that extend to the fold between the lid and the eyebrow. A horizontal incision, *e, f,* joining these two and extending 1 or 2 mm. on either side of them, is then made. This incision passes through the skin and muscle to the tarso-orbital fascia. The nearly rectangular flap is then dissected up, by separating it from the tarsus, so that it contains fibers of the orbicularis.

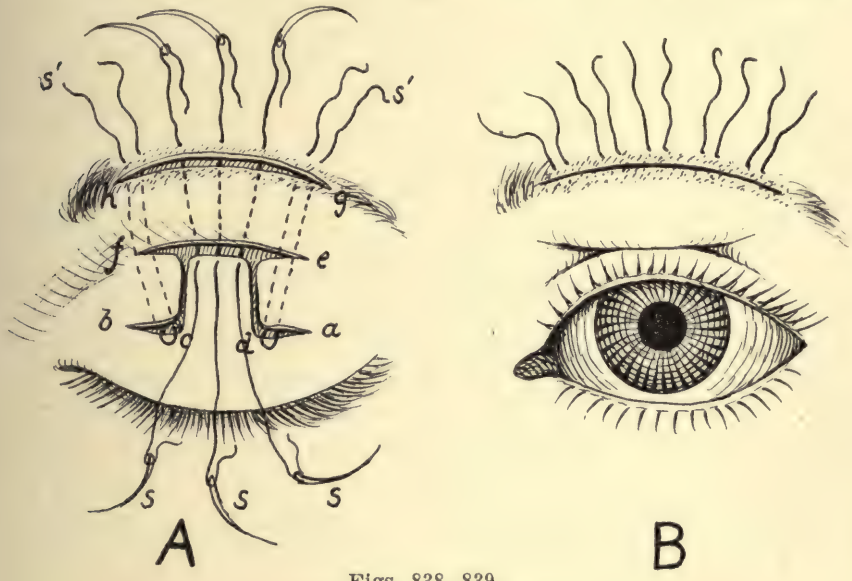
A third incision, *g, h,* parallel to the preceding, is then made through the skin and deep tissue of the eyebrow, and the bridge of tissue, *e, f, g, h,* thus marked out, is undermined. The distance one must place the incision, *g, h,* from *f, e,* will depend upon the degree of elevation of the lid when one draws the flap upward; hence the degree of elevation is practically equal to the width of the bridge. Three sutures pass through the upper edge of the rectangular flap, then be-

[81] Panas. D'un nouveau procédé opératoire applicable au ptosis congenital et au ptosis paralytique. *Archiv. d'Ophtal.*, 1887, Vol. VI, p. 1.

neath the bridge to the upper lip of the incision in the eyebrow. These sutures can be more readily passed beneath the bridge and the flap drawn up into place if the bridge is drawn forward with a strabismus hook.

When the flap is in position there may be a tendency to slight ectropion. To obviate this, before drawing the flap beneath the bridge, Panas placed two lateral loop sutures, *s*, *s*, which take hold of the edge of the tarsus and the fascia where it is exposed behind the points, *c*, *d*, and emerge above the brow. Traction on these tends to draw the tarsus straight up. They may be tied over rolls of gauze.

This operation is applicable for cases of complete ptosis in which there is absolutely no power of the levator. It will unquestionably



Figs. 838. 839.

Panas' Operation for Ptosis.

Incision *a*, *b*, are made parallel to the lid border and about on a level with the superior border of the tarsus. The line of this incision is interrupted at *c*, *d*. From these points two vertical incisions are made up to the fold between lid and eyebrow. These are joined by an incision, *e*, *f*, and the rectangular flap is loosened. *g*, *h*, shows the incision in the brow. The bridge, *e*, *f*, *g*, *h*, is undermined, and beneath it the rectangular flap is fixed by sutures. *s*, *s*, are loop sutures taking hold of the tarso-orbital fascia and emerging above the brow. *b*, completed operation.

raise the lid, but has the distinct disadvantage that it places the skin surface of the flap in apposition with the raw under surface of the bridge. Healing of this under surface must be by granulation, hence the recovery is considerably delayed. Furthermore, the little pocket thus formed gathers dirt and epithelial scales and is not easy to keep clean.

For these reasons, several modifications of this method have been suggested that are real improvements and make it a desirable operation of its class.

Allport's Modification of Panas' Operation.[82]

The chief features of this operation are a thorough denudation of the tongue flap so that it may grow to the raw surface of the bridge, and removal of the corners of the lateral flaps on the lid surface, to make them fit more accurately and thus avoid puckering of the lid.

The incisions are made like those described by Panas, Allport, however, making first the incision above the brow, the length of the palpebral fissure and extending to the bone, *a, b.* The second incision, *c, d,* is made about the same length as the first, as in Fig. 841, just below the eyebrow, and should also extend to the bone. Two parallel, vertical incisions extend from this incision to points about on a level with the superior border of the tarsus. Horizontal incisions, *e, f,* and *g, h,* are then made from these, as in the Panas procedure. The bridge is then undermined from one end to the other, and in addition to this it is everted, and all the soft tissues removed, making this flap, consisting mostly of integument, as thin as possible. The tongue flap should be dissected up, and this he also makes as thin as possible, dissecting away the muscle fibers. The cutaneous surface of the flap is thoroughly scarified (if possible denuded of epithelium) to make it adhere to the under surface of the bridge flap. This is a distinct advantage. The lateral flaps on the side of the vertical incisions are also undermined and their corners cut off, as indicated in the figure, giving them a pointed appearance. Sutures are introduced, as in the Panas operation, three serving to hold the tongue flap in position under the bridge and uniting it to the upper lip of the superior incision; and two lateral ones, *4* and *5*, double-armed sutures that pass from the conjunctival side of the lid outward through the fascia, the loop remaining on the conjunctival side.

These lateral sutures, as in the Panas operation, serve to prevent ectropion. Four superficial sutures unite the skin at the angles made by cutting off the lateral flaps, as indicated in the drawing. All sutures, except those of the tongue flap, are removed in four days; the others are allowed to remain about ten days, to insure union of the parts.

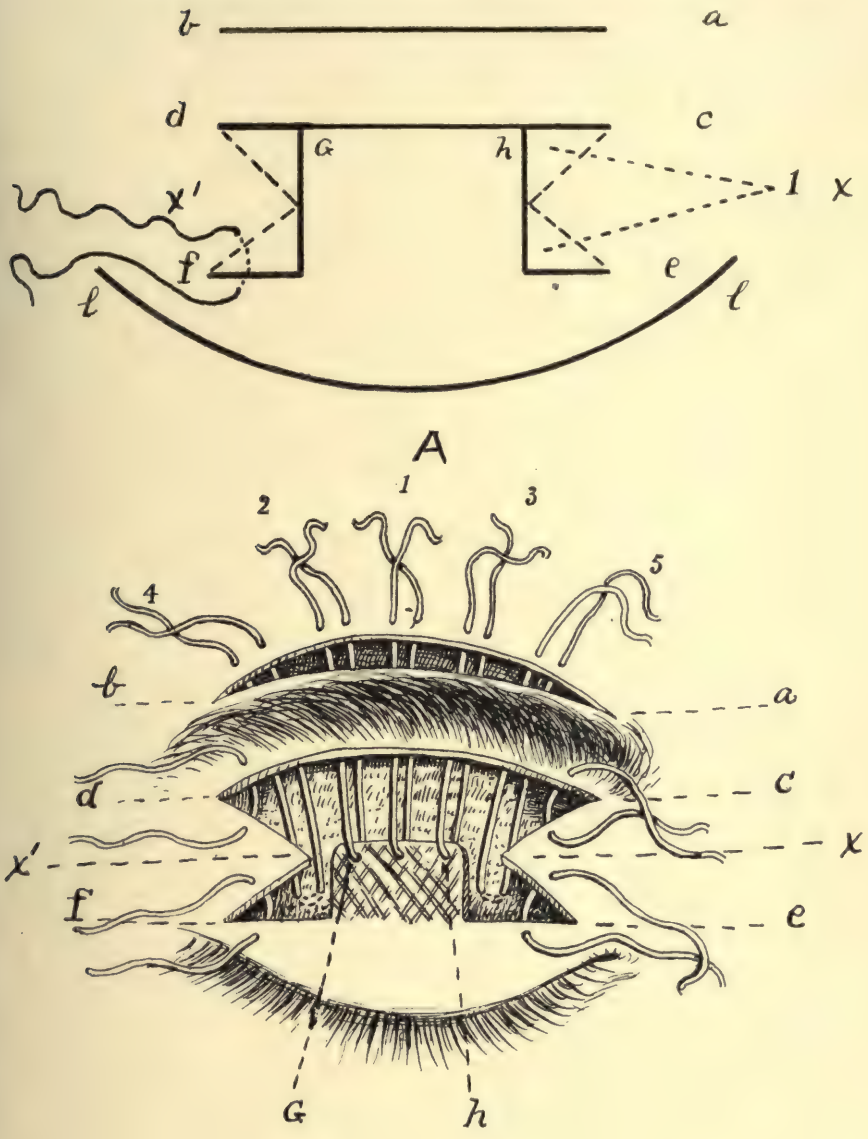
Grimsdale's Modification of Panas' Operation.

Grimsdale[83] offers his modification to avoid the objectionable co-

---

[82]Allport. Modification of Panas' Operation for Ptosis. *Jour. Am. Medical Ass'n*, April, 1903; also, Personal Communication.

[83]Grimsdale and Brewerton. *A Textbook of Ophthalmic Operations*, 1907, p. 72.



Figs. 840, 841.

Allport's Operation for Ptosis.

A. Diagram of the Incisions.

B. Field of Operation showing the Sutures in Position.

a, *b*, incision above the eyebrow, extending to the bone.

c, *d*, incision below the eyebrow.

g, *h*, superior border of the tongue flap, separated from its original position along the line of incision, *c*, *d*. The cutaneous surface is denuded of epithelium.

x, *x*, lateral flaps, undermined and made pointed by cutting off the corners.

aptation of skin to a granulating surface, which is the chief disadvantage of the Panas operation.

The first incision is made in the usual way above the brow. (Fig. *a, b.*)

If the amount of elevation desired is about 6 mm. the surgeon makes two shorter incisions, *c, d,* and *e, f,* about 3 mm. below the first and separated by a space of 10 mm. From the inner ends of these, two vertical incisions, *d, g,* and *e, h,* are carried downwards for about 12 mm., and then turned slightly towards the inner and outer extremities of the lid.

The whole area marked out by these incisions is then undermined so that it will move readily.

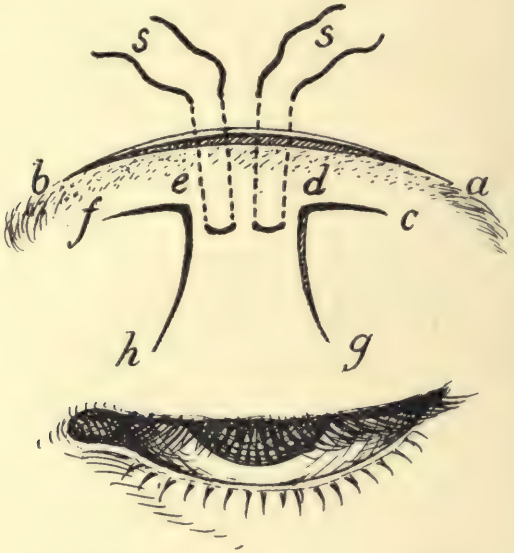


Fig. 842.

Grimsdale's Modification of Panas' Operation.

a, b, incision above the eyebrow.

c, d, e, f, short incisions, 4 mm. or 5 mm. below *a, b.*

d. g. and *e. h.* vertical incisions extending downward to the upper border of the tarsus and diverging slightly below.

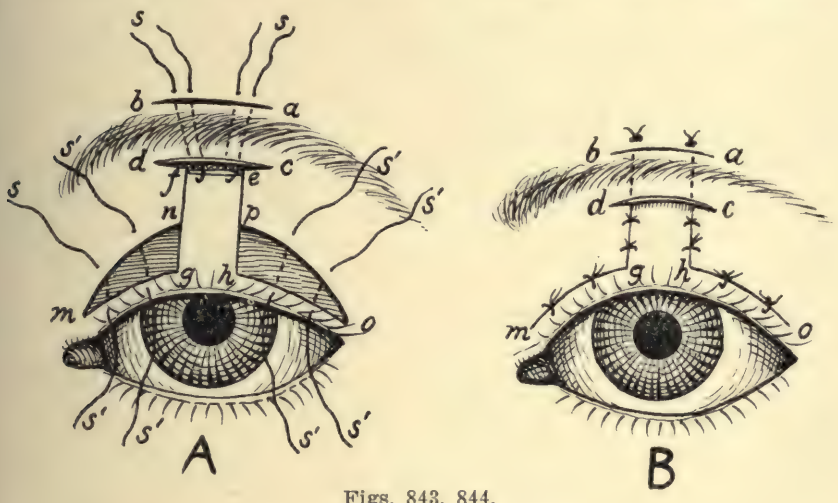
The tissue thus outlined is undermined, so that it will slide upward and elevate the lid by traction on the sutures.

Two stout, double-armed sutures are passed through the skin between the vertical incisions, at a distance of 6 mm. from the first incision, and then upward, under the loosened skin to the first incision; here they sink deeply through the frontalis to emerge above the brow. When tightened, the loose fold of skin between the vertical incisions is drawn up under the eyebrow, to be attached to the frontalis. The sutures are then tied over rolls.

Tansley's Operation for Ptosis.[84]

This is a combination of the principles of Hunt and Graefe with that of Panas, as shown in the accompanying figures.

Two vertical, parallel incisoins, about 6 mm. apart, are made in the center of the lid, extending from the orbital margin below the eyebrow to points about 4 mm. above the free border of the eyelid. At their upper ends these incisions are united by a horizontal one, *c, d,* and the tongue flap, *e, f, g, h,* is separated by dissection with knife and scissors, leaving it attached at *g, h.* This narrow flap is then wrapped in a piece of gauze wet with warm salt solution, and the incisions, *h, o,* and *g, m,* are made from the base of the flap, parallel to and about 4 mm. from the free border of the lid, extending a trifle beyond the internal and external canthi. Joining these at each end are



Figs. 843, 844.

Tansley's Operation for Ptosis.

a, b, incision above the brow, 12 mm. long.
c, d, incision below the brow, 12 mm. long.
e, h, f, g, tongue flap of skin dissected back and left attached at *g, h.*
m, g, h, o, incision, 3 mm. from the border of the lid, joined by *n, m,* and *p, o,* that follows the line of the superior border of the tarsus.
s, s, sutures in the end of the tongue flap draw it under the bridge, to attach it to the lip of the incision, *a, b.*
s, s, sutures closing the wound in the lid.
B, appearance after closing the wound.

two curved incisions, *p, o,* and *n, m,* that follow the crease showing the upper limit of the tarsus. The skin and muscle fibers between these incisions are then excised, leaving the tarsus denuded of tissue.

A short incision, *a, b,* 8 or 10 mm. long, is then made above the

[84]Tansley. A Congenital Ptosis Case and Operation. *Trans. Amer. Ophth. Soc.*, 1895, Vol. VII, Pt. II, p. 427.

eyebrow, parallel to and directly over the one below the brow, *c*, *d*, and the tissue is undermined with a Graefe knife, to allow the passage of the end of the tongue flap.

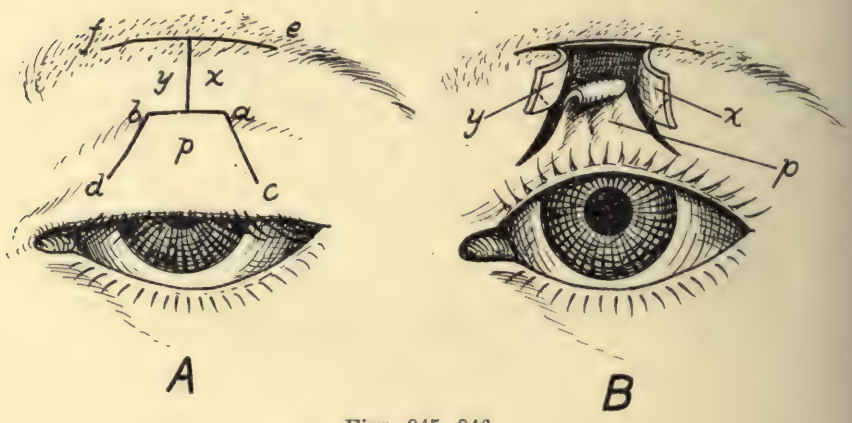
A strong suture in the end of this flap is used to draw it up beneath the brow, and when it is sufficiently tight to produce the required elevation of the lid any excess is cut off even with the forehead. The little flap is then united to the upper skin incision with two fine sutures. Superficial sutures close the denuded area and unite the sides of the tongue flap to the lips of the vertical wounds.

The sutures are removed from day to day, as seems advisable.

Here, again, there is the disadvantage of a cutaneous surface being apposed to a granulating one, but the operation is said to give excellent results in cases of complete ptosis.

Rollet's Ptosis Operation.

Rollet[85] endeavors to overcome the objection of having a raw



Figs. 845, 846.

Rollet's Operation for Ptosis.

a, *b*, incision, about 12 mm. in length, just beneath the brow.

a, *c*, *b*, *d*, diverging incisions down to 4 mm. above the edge of the lid, marking out flap *p*.

e, *f*, incision in the eyebrow, that has been previously shaved. A vertical incision joins these at middle points.

x, *y*, lateral flaps that are dissected back, giving place for accurate disposition of the flap *p*, which is slightly trimmed and united to the muscle layers by deep, catgut sutures. Superficial sutures unite the lateral flaps with the edges of the tongue flaps.

surface in contact with a cutaneous one by a modification of the Panas principle, in which the skin flap is more accurately attached to the frontal muscle.

The eyebrow is shaved.

---

[85]Rollet. Traitement du ptosis par la blépharopexie frontale à ciel ouvert. *Révue gén. d'Ophtal.*, Feb. 28, 1910, p. 49.

He makes a horizontal incision in the orbito-palpebral fold about 12 mm. in length, according to the subject. Fig. 845, *a, b.*

From this incision two diverging incisions pass downwards toward the border of the lid. The flap thus marked out, *a, b, c, d,* is separated by dissection from the underlying parts, and contains skin and orbicular muscle fibers.

A horizontal incision is then made in the eyebrow, about 2 cm. in length, extending to the bone, *e, f,* and from the middle of this a vertical incision is made between the two horizontal incisions. The upper part of this vertical incision is as deep (reaching the bone) as the superior one, while the lower part is superficial where it joins the lower incision.

The two lateral flaps, *x, y,* are then dissected back and the corners trimmed off, to avoid too great puckering. The palpebral flap is then drawn up to the required extent, and it, too, is trimmed to a somewhat pointed form with scissors, to make the lateral flaps fit it. It is then held in place by two layers of sutures, the deeper ones, of catgut, uniting the orbicularis muscle fibers in the flap with the fibers of the frontalis, that can be seen in the upper lip of the incision, and the lateral flaps, *x* and *y*. Finally, cutaneous sutures of silk close the wounds, by uniting the edges of the lateral flaps with the edges of the tongue flap.

Ptosis Operation of Darier.

Darier[86] endeavored to secure the tissues of the lid to the frontalis muscle by attaching small strips of orbicularis muscle to it.

This he did by excising a narrow oval strip of skin from the eyelid. He then, by dissection, prepared two small tongues of muscle fibers from the exposed orbicularis, 3 mm. wide and 15 mm. long. He then made two narrow tunnels beneath the eyebrow emerging above it, and into these the narrow tongue flaps of muscle were passed and secured with sutures.

Class II, Group c. Substitution of the Action of the Frontalis for That of the Levator Palpebræ, by Attaching a Flap of the Former Muscle to the Lid.

Operation of Fergus.

Fergus[87] recommends preparing a tongue flap of frontalis muscle fibers and suturing it to the anterior face of the tarsus. An incision is made, the length of the eyebrow, extending upward at its temporal end. The upper lip of the wound is dissected upward for 2 or 3 cm.,

[86] Darier. *Soc. d'Ophtal. de Paris*, 1897, p. 110.

[87] Fergus. *Brit. Med. Jour.*, March 30, 1901. Also, *Trans. Ophth. Soc., U. K.*, 1908, p. 184.

exposing the frontalis muscle. The lower flap of the wound is dissected downward, the orbicularis being included nearly to the free border of the lid, exposing the tarsus.

With the upper flap strongly retracted, the surgeon prepares a tongue-shaped flap of the frontalis muscle opposite the center of the lid, nearly 2 cm. broad and 3 or 4 cm. long, which is then separated from its attachment at its lower end.

Two double-armed loop sutures are passed through the free end of the flap of muscle from without inward, and then the needles take a firm hold of the tarsal plate, and finally emerge from the skin near the free margin of the lid. The sutures are tied over a small piece of tubing, and the wound in the brow is closed by ordinary sutures.

Class II, Group d. Attaching the Tendon of the Levator Palpebræ to the Frontalis.

This method is practised to give the frontalis a direct attachment to the lid, but instead of drawing the lid upward and backward as the levator does, it cannot do better than draw it straight upward, as do all the operations in Class II.

Ptosis Operation of Angelucci[88].

An incision is made 3 or 4 mm. beneath the line of the eyebrow, and parallel to it, about 2½ cm. in length. Fig. 847, *a, b.*

The lower flap is dissected down to the level of the superior border of the tarsus and held back by retractors. Two or three mm. above the superior border of the tarsus a horizontal incision is made through the fibers of the orbicularis, to lay bare the tendon of the levator.

The tendon is then raised on a strabismus hook and divided 4 mm. above its attachment to the superior border of the tarsus. The tendon is then transfixed by two double-armed loop sutures, the needles passing from before backward, and the loops are tied on the posterior surface of the tendon, to prevent the threads from pulling out.

The tissues beneath the eyebrow are then separated from the periosteum, and the needles are passed beneath, to emerge on the skin, 2 to 5 mm. above the brow. The sutures are then drawn sufficiently to uncover the pupil, and tied with bow-knots over a piece of gauze or tubing. Skin sutures are almost unnecessary. At the end of twenty-four hours the sutures may be tightened or loosened, as the case requires.

This operation is not applicable to cases in which the tendon of the levator is much atrophied, or is altogether absent.

---

[88]Angelucci. Nouveau procédé d'opération pour le ptosis paralytique. *Compt. rend. XIII. Congrés internat. de Médicine*, Paris, 1900, p. 329.

Ptosis Operation of Sourdille.

Sourdille[89] modifies this procedure so as to preserve the orbito-palpebral fold. He makes a curved incision 2½ cm. in length (as shown in Fig. 848) and so placed that the summit of the curve will be at about the superior border of the eyebrow; the extremities 2 mm. beneath the inferior border. The incision extends through skin, connective tissue and muscle down to the periosteum. By dissecting the lower flap downward he lays bare the upper part of the septum orbitale. This is divided near the orbital margin for a length of 1½ or 2 cm. The orbital fat that presents is pushed aside and the levator palpebræ seized on a strabismus hook, and two sutures are passed through it. These are passed as follows: Each needle, on a double-

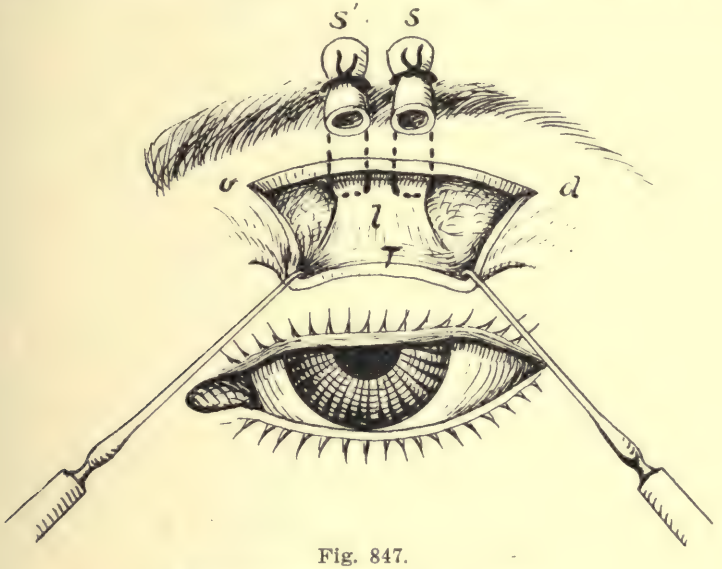


Fig. 847.

Angelucci's Operation for Ptosis.

a, *b*, line of incision, 4 mm. below the brow, 2½ cm. long.
t, superior border of the tarsus.
l, tendon of the levator, which is divided and held up by loop-sutures, *s*, *s*, that emerge above the brow.

armed suture, is passed through the tendon from behind forwards, the threads are then crossed and the needles transfix the tendon at a higher level, the suture thus making an X on the anterior surface of the tendon. When two such sutures have been passed, the tendon is divided.

A pocket is made under the eyebrow by separating the tissues from the periosteum with a scalpel, and the tendon is drawn up into

[89]Sourdille. *La Clinique Ophtalmol.*, 1903, p. 73.

this pocket by passing the needles attached to each suture through the frontalis muscle, to emerge on the skin 3 or 4 mm. from the superior border of the incision.

Each suture is tied over a piece of gauze or tubing with a temporary knot, so that the suture may be tightened or loosened the next day, if necessary. Skin sutures close the wound, and the sutures may be removed at the end of the seventh or eighth day. Whether or not the tendon will act, pulley-like, around the margin of the orbit, as claimed by the author, is questionable; the probability is that the traction will be straight upwards, and in some cases with prominent brows upward and forward, so that there will be danger of throwing the lower border of the lid inward, thus causing entropion.

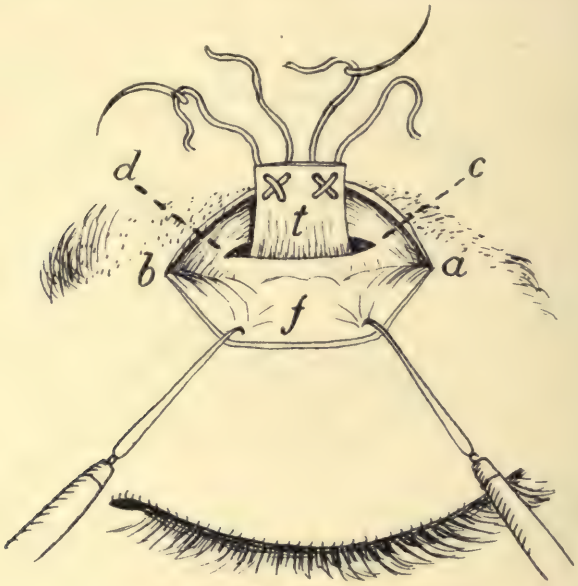


Fig. 848.

Operation of Sourdille for Ptosis.

a, *b*, curved incision in the skin, beginning 3 mm. below the line of the brow and extending to its upper edge.

f, lower flap dissected down and retracted.

c, *d*, incision in the tarso-orbital fascia, just beneath the orbital margin.

t, end of the divided tendon of the levator, through which are passed the sutures *en* X, preparatory to directing them into the pocket under the eyebrow.

CLASS III. ADVANCEMENT OF THE POINT OF INSERTION OF THE LEVATOR PALPEBRÆ.

In considering the action of the upper lid, which rolls upward and backward like the visor of a helmet, or the cover of a roll-top desk, the tarsus may be regarded as the continuation of the tendon of

the levator palpebræ. Hence, for all practical purposes, the point of insertion of this muscle is advanced if a part of the tarsus is excised, or if a portion of the tendon is removed or folded on itself. All operations, therefore, that aim to shorten the skeleton of the lid by cutting out a piece of the tarsal plate, should be included in this class.

While operations of the preceding class are applicable to cases in which the levator is powerless, those now to be considered are suitable to those cases of partial ptosis in which the muscle retains a certain degree of power.

Sir William Bowman was probably the first to suggest and put into practice the principles of operations in this class, by excising a piece of the tendon, thus shortening it, and of shortening the lid by removing a portion of the tarsus. These original operations have been modified in various ways by Eversbusch, Grandmont and others.

Class III, Group a. Partial Excision of the Tarsus and Levator Tendon. Bowman's Operation for Ptosis[90].

The upper lid is strongly everted, and an incision is made through the conjunctiva along the length of the superior border of the tarsus.

The conjunctiva is then dissected back with scissors and forceps so as to expose the tendon of the levator and the superior tarsal border.

The tendon is then seized with toothed forceps, and two or three sutures are passed through it at points about 2 cm. back of its insertion. It is then cut off in front of the line of the sutures, and this piece, together with the superior border of the tarsus to which it is attached, is excised with the scissors. The needles on the sutures are then passed through the fresh border of the tarsus and the tendon attached to its new position.

Class III, Group b. Advancement of the Levator by Folding the Tendon.

The principle proposed by Bowman was followed by Eversbusch, who, instead of excising a piece of the tendon and tarsus, accomplished the same result by folding the tendon by means of loop sutures placed through it.

Operation of Eversbusch[91].

General anesthesia is employed, and a Snellen clamp is placed as high up beneath the lid as possible. Before the clamp is set the lid should be drawn down between the blades and, in this position, fixed.

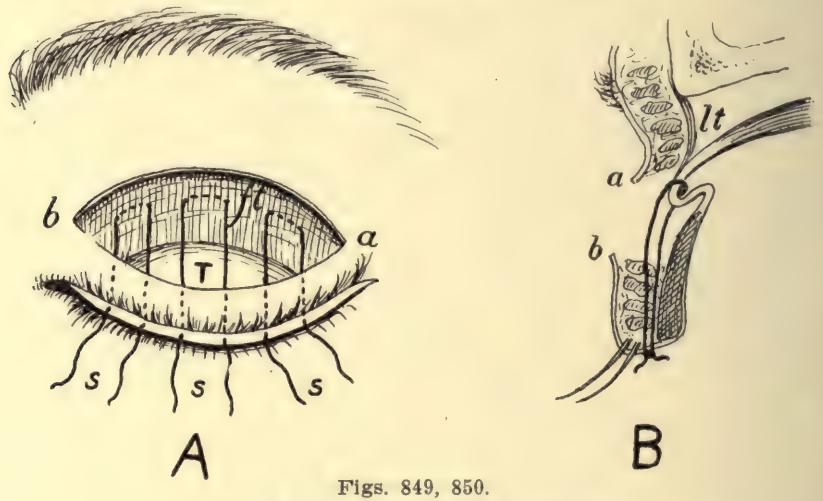
An incision the length of the lids is then made parallel to the lid border and half way between it and the eyebrow, through skin and muscle. (Consult Fig. 849.)

[90]Bowman. *Royal London Ophthalmic Hosp. Reports*, Vol. I, p. 34.

[91]Eversbusch. Zur Operation der congenitalen Blepharoptosis. *Klin. Monatsbl. f. Augenheilk.*, 1883, p. 100.

The upper and lower lips of the wound are then separated from the fascia and tarsus by loose dissection, so as to lay bare the tendon of the levator.

A suture of silk or fine catgut, doubly-armed with fine, curved needles, is then passed through the middle of the tendon, 3 or 4 mm. from the superior tarsal border. This is best done by seizing a vertical hold of the tendon with fine toothed forceps, passing one needle through it (not including the conjunctiva) and bringing it out 2½ mm. from the point of entrance. The two needles then pass between the orbicularis muscle and the tarsus, to emerge on the gray line just behind the eyelashes, about 2½ mm. apart. A similar suture is passed about 3 mm. on each side of the central one. There are thus formed three loops on the posterior surface of the tendon. Before tying the



Figs. 849, 850.

Operation of Eversbusch for Ptosis.

a, *b*, incision in the skin and muscle, exposing the tarsus, *t*, and *f*, *t*, the fascia, with the levator tendon.

s, loop sutures through the tendon, emerging at the border of the lid behind the lashes, fold the tendon forward, as indicated in the vertical section at *B*.

sutures, the clamp is removed, and the musculo-cutaneous wound is closed with three sutures.

The tendons are tied over beads, as in the Snellen entropion operation, to prevent them from cutting into the lid margin.

Tightening the sutures folds the tendon forward on the anterior surface of the tarsus.

In cases of redundancy of skin and muscle, Eversbusch recommends the excision of a strip of skin and muscle before closing the wound, after the manner of Graefe.

Both eyes are bandaged and the dressing is changed each day. The sutures are allowed to remain for several days, until there is sufficiently firm union between the folds of the tendon and the tarsus.

Snellen's Operation for Ptosis.

Snellen[92] suggested folding the tendon by the use of sutures alone, omitting the incisions. He passed a suture through the whole thickness of the lid just at the upper border of the tarsus. The lid was then everted, and the same needle was passed as high up in the fornix conjunctivæ as possible, through conjunctiva and underlying tendon and nearly to the skin of the lid. However, instead of piercing the skin, the needle was directed downward towards its original point of entrance, and emerged from the skin, about 2 mm. from this point.

Three such sutures are necessary, at equal distances apart, to correct the ptosis; and, because of the situation of the tendon of the levator, the middle one should be placed slightly nearer the internal angle of the lid than the external.

The sutures thus placed form loops through the tendon and draw it forward. They are tied over beads or pieces of tubing.

Wolff's Operation for Ptosis[93].

For cases of this Class, Wolff proposes two forms of operation, one an advancement of the levator tendon after division of its tarsal insertion, made through a cutaneous incision; the other an advancement of Müller's muscle, done through a conjunctival incision. In the first operation a cutaneous incision is made 2 cm. in length, corresponding to the superior border of the tarsus. The skin is separated from the underlying muscle for 3 mm. above the incision and nearly to the free border below. About in the center of the convex tarsal border a fold of the muscle, with the underlying tendon, is seized with toothed forceps, and two vertical incisions, 1 cm. apart, are made with scissors through muscle and tendon. Beneath the bridge of muscle and tendon are then placed two strabismus hooks. (See Fig. 851.)

Two double-armed catgut sutures are now passed through the tendon at a point high enough to allow resection of a piece of the tendon equal in length to the difference of width of the palpebral fissures. The sutures are tied, and the tendon divided immediately in front of them. The sutures are then passed through the stump of the tendon and the overlying orbicularis fibers at the superior border

---

[92]Snellen. A New Operation for Ptosis. *Trans. Ophthal. Soc., U. K.*, 1889, Vol. X, p. 207. Also, *Annales d'Oculist.*, 1890, Vol. CIV, p. 69.

[93]Wolff. Vorlagerung des Musc. levator palp. sup. (Musc. Mülleri) mit Durchtrennung von der Conjunctiva aus. *Archiv f. Augenheilk.*, 1896, Vol. XXXIII, p. 135. Also, *Berliner Klin. Wochenschr.*, 1897, No. 46.

of the tarsus and tied. The skin wound is closed with three or four sutures which may be removed in four or five days.

By leaving the orbicularis intact, it is claimed that the union of the levator with the tarsus is made more secure, in that the tendon has an attachment, through the orbicularis, with the anterior face of the tarsus, in addition to that at the superior border.

In the other *operation of Wolff, for shortening the muscle of Müller,* the lid is held doubly everted, and a horizontal incision of 2 cm. is made in the fornix of the conjunctiva, exposing the muscle, which is then taken up on strabismus hooks. Catgut sutures are placed in the tendon as in the preceding operation, just back of the point where it is desired to resect the muscle. This point is deter-

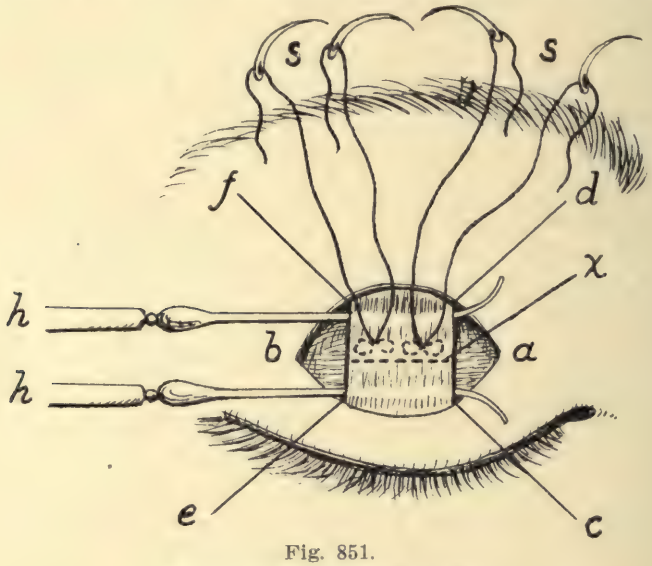


Fig. 851.

Operation of Wolff for Ptosis.

a, *b*, incision through the skin, 2 cm. long, exposing the orbicularis fibers over the superior border of tarsus.

c, *d*, and *e*, *f*, vertical incisions through the muscle and the levator tendon, to allow the tendon to be held up by hooks, *h*, *h*.

s, *s*, catgut sutures passed through the muscle and tendon, 6 mm. or 7 mm. above the line of insertion in the superior tarsal border. The tendon is then divided just below these, along the dotted line *x*, and the sutures attached to the superior tarsal border behind the remaining stump of the tendon.

mined by the difference in width of the palpebral fissures. After two sutures are placed in the tendon and tied, the tendon is cut off and the sutures are then passed through the superior border of the tarsus, tied and cut short. Five catgut sutures close the wound in the conjunctiva.

Both these operations are elaborate modifications of that of Bowman and are, in effect, a shortening of the levator tendon.

Ptosis Operation of Lapersonne.

Lapersonne[94] has offered a modification of the Wolff operation, in which he makes a practical advancement of the point of insertion of the tendon of the levator, attaching it to the anterior surface of the tarsus, as shown in Fig. 852.

A horn or metal plate is held beneath the lid, and an incision, *a, b,* is made through skin and muscle the length of the lid, about 4 mm. or 5 mm. above its free border. By light dissection the tarsus and the tarso-orbital fascia with the levator tendon are laid bare.

Two small, vertical incisions, not involving the conjunctiva, are

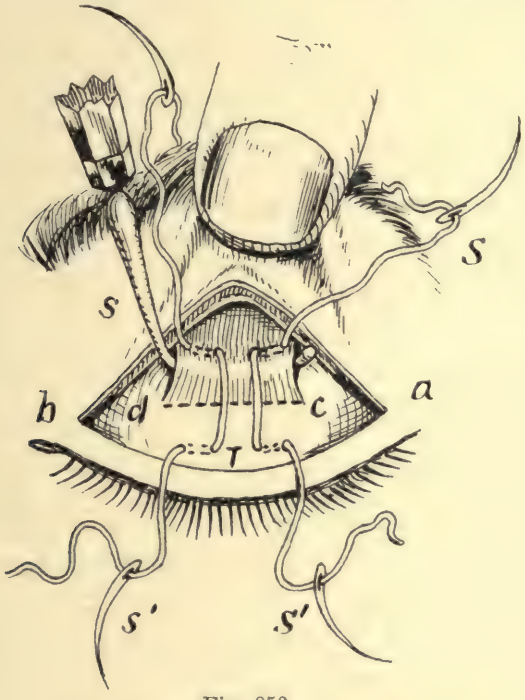


Fig. 852.

Lapersonne's Operation for Ptosis.

a, b, incision through skin and muscle, exposing the tarsus, *t,* and the tendon of the levator. Two vertical incisions at the side of the tendon, from *c* and *d,* allow the tendon to be raised on the hook.

s, s, sutures forming a loop on the back of the tendon.

s' s' sutures passing through the tarsus.

c, d, line of division of the tendon at the tarsal border.

made on either side of the tendon, to permit the introduction of a strabismus hook with which to raise it.

At a distance above the hook, depending upon the amount of ele-

[94]Lapersonne. Sur quelques modifications dans les opérations du ptosis. *Archives d'Ophtal.*, August, 1903, p. 497.

vation to be obtained, there is passed, through the lateral part of the tendon, one needle of a double-armed suture, which emerges 2 mm. from its point of entrance. A similar suture is passed through the outer half of the tendon, thus making two loops behind it.

The attachment of the tendon to the tarsus is then divided at *c*, *d*, and, if deemed necessary, a piece of it may be resected.

The other needles on the sutures are then passed into the tarsus at a distance of 2 mm. or 3 mm. from the free for border, *s'*, *s'*. When the sutures are tied, the tendon is drawn down, to attach itself to the face of the tarsus. The skin wound closes naturally without the aid of sutures. The effect may be increased, however, by resecting a small strip of skin and muscle fibers, in which case the wound will be closed with fine sutures.

Elschnig's Operation for Ptosis[95].

The lid is held on a Jaeger lid plate, and an incision is made down to the tarsus, 5 mm. above the lid border.

The tissues are dissected back, above and below, to expose the tarsus and the tarso-orbital fascia. 10 mm. above the convex border of the tarsus, the fascia is seized in a thread loop, and then cut just below the loop from the median to the lateral angle. Retracting the fascia by means of the thread loop, the lower part of the fascia is carefully dissected away from the tendon and tarsus with scissors, nearly to the lid border.

The tendon of the levator, now in view, is seized with forceps, a loop suture is placed through it for control, and it is severed without cutting the conjunctiva. Holding it forward by means of the control suture, two or three fine, double-armed sutures are passed through it at such distances from the cut end as will insure the proper effect. The needles are then passed through the tarsal tissue, about 3 mm. from the lid border, and out through the skin.

Five catgut sutures then close the wound in the fascia; that in the skin is united with silk. After the skin wound has been closed, the tendon loops are tightened and draw the tendon down to its new attachment on the anterior face of the tarsus. They are then tied with bow-knots over pieces of tubing or gauze rolls; and the effect can be increased or diminished by tightening or loosening, at subsequent dressings. The superficial sutures are removed in three days; the deep sutures are allowed to remain from five to eight days.

It is difficult to understand the necessity for such a complicated dissection in order to attach the tendon to the anterior surface of the tarsus. The effect produced is the same as in the Lapersonne opera-

[95]Czermak-Elschnig. *Die Augenärztliche Operationen*, Vol. I, p. 273.

tion. Having the sutures emerge on the skin, to be tied over rolls, as in the Snellen procedure, seems to be an advantage.

Class III, Group c. Advancement of the Point of Insertion of the Levator Tendon by Excision of a Strip of Tarsus.

As was previously stated, shortening the skeleton of the lid, the lid plate, by removal of a piece of it, is equivalent to resecting a piece of the tendon of the levator, so far as the action of that muscle on the lid is concerned. Whether or not one should remove a piece of the tarsus large enough to correct the deformity, is a question for careful consideration in any case.

Bowman[96] seems to have been the first to conceive this idea and put it into practice, although the report of the case he publishes is rather incomplete. He made a skin incision parallel to and about 8 mm. above the lid border. Separating the wound, he excised an oval piece of subcutaneous tissues, including the tarsus and conjunctiva, and united the cut edges with sutures.

Ptosis Operation of Gillet de Grandmont[97].

The lid is held in a Snellen clamp, and an incision is made in the lid 2½ cm. in length, parallel to the free border and 3 or 4 mm. from it. (See Fig. 853.)

The wound is separated and the orbicularis fibers covering the tarsus are excised, leaving the latter bare in its whole extent.

An incision is then made through the tarsus and conjunctiva, parallel to the lid border, and 2 mm. or 3 mm. above it, this incision, *c, d,* being about 2 cm. in length. Joining this at each end is a curved incision, *c, e, d,* with its concavity downwards, passing through all the tissues to the blade of the lid clamp. The distance of the curved incision from the inferior one must be carefully determined by the degree of effect to be produced. At the widest part this distance should be equal to the difference in width of the palpebral fissures at the widest part, if one is normal.

The tissues bounded by these incisions are then removed. The edges of the deep wound thus made are united with fine catgut sutures. The skin wound will usually not require any.

Nicati[98] modified this procedure by excising the tarsus from the conjunctival side. The lid is everted, and each needle of a double-armed suture is passed through the conjunctiva at the superior border of the tarsus, and made to glide along the anterior surface of the tarsus and emerge on the free border of the lid just behind the eye-

---

[96]Bowman. *Royal Lond. Ophthal. Hosp. Reports,* Vol. I, p. 34.

[97]Gillet de Grandmont. Nouvelle opération du ptosis congenital, *Bulletins et Mémoires de la Soc. franç. d'Ophtalm.,* Vol. IX, 1891, p. 80.

[98]Nicati. *Archives d'Ophtalm.,* 1890, Vol. X, p. 182.

lashes. Three such loop-sutures are passed at equal distances apart, after which a large portion of the tarsus is excised, preserving as much of the conjunctiva as possible. The sutures are then forcibly tied, and removed in three days.

Boucheron[99] prefers an operation from the conjunctival side in cases of mild ptosis in women, to avoid the scar in the skin. Everting the lid, he first does a tarsectomy, reserving a band of tarsus above to which is attached the tendon of the levator, and one below, in which the lashes are placed.

Through this opening in the tarsus a part of the orbicularis muscle is removed, as this is antagonistic to the levator. Finally, the defect in the tarsus is closed by fine sutures.

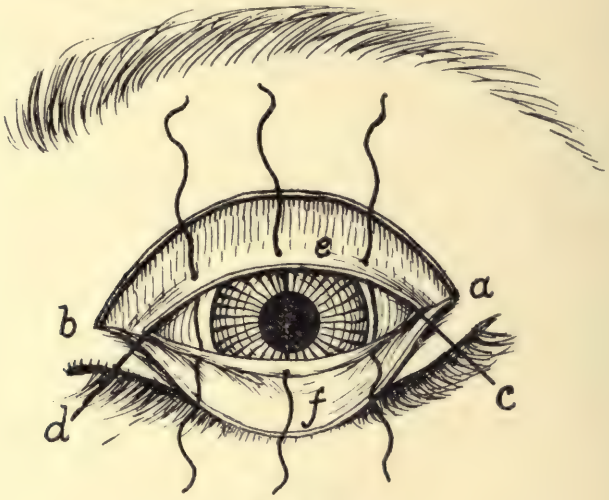


Fig. 853.

Operation of de Grandmont for Ptosis.

a, b, incision through the skin and muscle, exposing the tarsus and the tarso-orbital fascia.

f, lower skin flap drawn downwards.

c, d, incision through the thickness of the tarsus, joined by the curved incision, *c, e, d*, near the upper margin of the tarsus; the tissue removed. The deep wound is closed by sutures.

Gruening[100] operates according to the method of de Grandmont, and thinks his method applicable to any form of ptosis requiring surgical intervention. The vertical width of the strip of excised tarsus should vary with the degree of the ptosis; it may measure as much as 7 mm., tapering at each end to 2 mm. He closes the tarsal wound by

[99]Boucheron. *Archiv. d'Ophtal.*, 1893, Vol. XIII, p. 561.

[100]Gruening. The Value of Partial Resection of the Tarsal Cartilage in the Operative Treatment of Congenital Ptosis. *Trans. Amer. Ophthal. Soc.*, Vol. IX, Pt. III, p. 574. Also, *New York Eye & Ear Inf. Reports*, Jan., 1904, p. 1.

inserting three double-armed, loop sutures through the tarso-orbital fascia near the superior tarsal border, and bringing them out through the edge of the lid behind the eyelashes and tying them in the intermarginal space. He finds that patients operated on by this method are able to close the eyes well.

Theobald[101] excised the tarsus from the conjunctival side, making his first incision 3½ mm. from the free border of the lid, and a second parallel to it and 3 mm. above. This strip of tarsus was removed and the wound closed by three fine, silk sutures. He did not excise any of the orbicularis muscle as did Boucheron. Placing knotted sutures on the conjunctival side of the tarsus, where they may come into contact with the cornea is not to be recommended, as they may cause serious ulceration. If the excision is to be performed from the conjunctival side it would be better to follow the plan recommended in the Nicati operation for closing the tarsal wound.

Fergus[102] follows the principle of the de Grandmont operation in his most recent work, but modifies it to the extent of removing an oval piece of skin and muscle equal to the size of the tarsus that is excised. In removing the piece of tarsus he spares the conjunctiva. He uses catgut sutures to unite the wound in the tarsus, and superficial sutures to close the defect in the skin.

Mayou,[103] after making a curved incision the length of the lid beneath the orbital margin, dissects back the skin and muscle so as to expose the tarsus and the tarso-orbital fascia. He then excises a strip 3 mm. broad from the whole length of the tarsal plate, without buttonholing the conjunctiva.

The cut margin of the tarsus is then attached to the levator palpebræ by two loop sutures of catgut, that pass through the tarsus below the wound, making a loop of about 3 mm., and then through the tarso-orbital fascia, tendon of the levator and orbicularis muscle in the upper part of the wound, where they are tied. The skin wound is closed with sutures. This would seem to be a combination of groups *b* and *c*—folding the tendon of the levator and excision of a part of the tarsus.

Some operators combine the principles of several groups that have been described. This is true of the procedure of Beard, in which the results are obtained by combining some of the features of the Hotz entropion operation with the principles of the Eversbusch operation of folding the levator tendon; also those of the Pagenstecher operation, of connecting the lid to the frontalis muscle by means of sutures.

---

[101]Theobald. A Simplification of de Grandmont's Operation for Ptosis. *Trans. Amer. Ophthal. Soc.*, 1908, p. 673.

[102]Fergus. *Trans. Ophthal. Soc., U. K.*, 1908, Vol. XXVIII, p. 184.

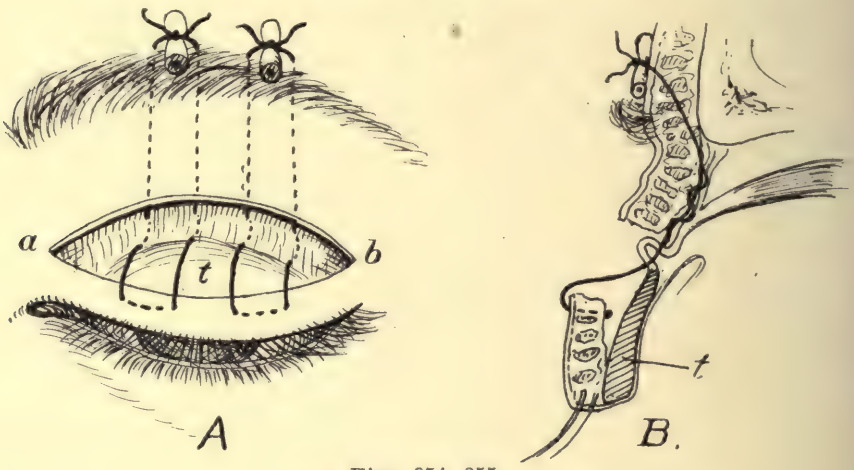
Beard's Operation for Ptosis[104].

After placing a horn plate beneath the lid, an incision is made just in the superior border of the tarsus, extending the whole length of the lid. (See Fig. 854.)

The divided fibers of the orbicularis are undermined above and below, exposing the tarsus and the tarso-orbital fascia. Two double-armed, No. 3, braided-silk sutures are passed in the following manner: Each needle on a suture is passed through the lower flap, near the edge from within outward, making the loop on its posterior surface.

The needles then pass in and out through the tendon of the levator and fascia, gathering it in folds, and finally emerge some distance above the eyebrow.

The sutures are so spaced that the loop, which is about 6 mm.



Figs. 854, 855.
Beard's Operation for Ptosis.

A. Front View.
a, *b*, incision at the superior border of the tarsus; *t*, tarsus. The sutures pass through the lower flap with the loop on its inner surface; they then gather the tarso-orbital fascia, and emerge above the brow.
B. Diagram of a vertical section of the lid, to show the course of the sutures.

long, is at the junction of the middle and end thirds of the tarsus. In tightening the sutures, the operator should, with toothed forceps, place the lower flap in proper position on the tarso-orbital fascia, and should also be sure that the edge of the upper flap is directed backward, that it may attach itself at the same point.

The sutures are then tied with bow-knots over gauze rolls, and can be tightened or loosened as desired when the dressing is changed

---

[103]Mayou. Burghard's *System of Operative Surgery*, 1909, Vol. IV, p. 267.
[104]Beard. *Ophthalmic Surgery*, 1910, p. 241.

after twenty-four hours. They are removed at the end of three or four days, when the parts have healed in their new position. The scar lies in the natural sulcus, above the tarsus.

Wilder's Operation for Ptosis.[105]

Some years ago the author proposed an operation for ptosis of folding upon itself the tarso-orbital fascia, as well as the aponeurosis of the levator which is intimately adherent to the fascia; and at the same time establishing a secure connection of the upper lid to the firm tissues of the eyebrow. It is a combination, therefore, of the principles contained in operations described in Class II, group *a*, with those described in Class III, group *b*.

The eyebrow is shaved, and an incision extending its whole length is made a little above the orbital margin, through all the tissues down to the periosteum. Retractors being used to draw down the lower lip of the wound, the skin and muscle are separated from the tarso-orbital fascia until the tarsus is brought into view. Sutures of fine, sterilized, hardened catgut, armed at each end with a curved needle are passed (see Fig. 856) in the following manner:

The first needle is introduced deep enough into the tarsus to secure a firm hold at a point about at the junction of the outer and middle thirds, and a little distance below its convex edge. It is then drawn through, and with it several gathering stitches, *b*, are taken in the tarso-orbital fascia, after which the needle is passed through the muscle and connective tissue of the upper lip of the wound, *c*. The other needle on the same suture follows a parallel course in the same manner, enters the tarsus about 3 mm. from the point of entrance of the first, then, gathering the fascia into small folds and emerging in the tissue above, makes a loop by which the lid is drawn up. The second suture is passed in the same way, making a loop at the junction of the middle and inner thirds of the tarsus. The desired elevation of the lid may now be secured by drawing on the loops and tying the sutures, which are to be left in the wound.

In milder degrees of ptosis, in which some power remains in the levator, the sutures may be placed somewhat nearer together, to secure a hold on the central fibers of the levator tendon, and may emerge on the skin above the eyebrow to be tied over rolls, as in the Pagenstecher operation. In such cases the sutures may be of silk, to be withdrawn after seven or eight days when some degree of union has occurred between the folds in the fascia. However, in cases of complete ptosis, with no power in the levator, the buried sutures give additional strength to the folds of fascia, become encapsulated, and unite

[105] Wilder. Operation for Ptosis. *Trans. Amer. Ophth. Soc.*, 1897, p. 99.

the lid to the frontalis, as well as shorten its suspensory ligament. The lower lip of the wound is united to the upper with fine sutures. The slight scar that remains after healing is almost entirely hidden when the eybrow grows again.

The orbicularis is uninjured, so that the patient retains to a certain extent the power of closing the lid.

This operation differs from that of Dransart in that there is a shortening of the septum orbitale, really the suspensory ligament of the upper lid, together with a slight folding of the aponeurosis of the levator muscle. Added to these is the principle of attaching the frontalis to the lid by means of encapsulated sutures.

Class IV. Substitution of the Action of the Superior Rectus for That of the Levator Palpebræ.

In this class of operations a new principle is introduced, of attaching the superior rectus muscle to the eyelid so that the lid will follow the upward movements of the eyeball. Furthermore, the move-

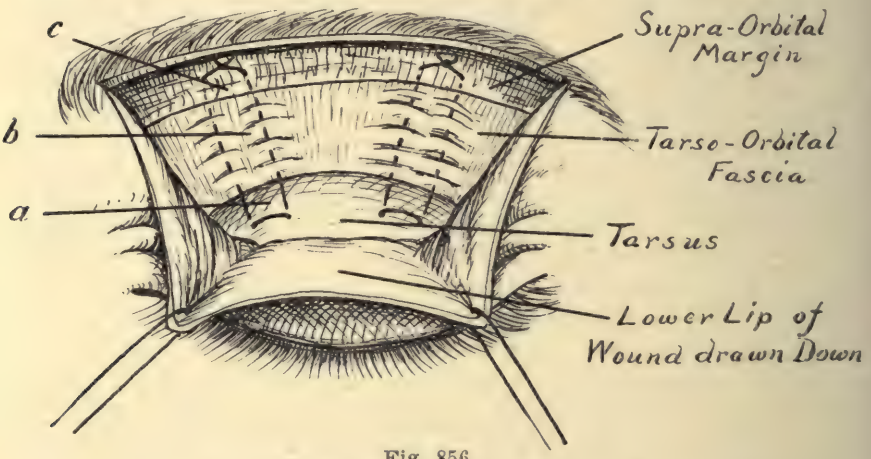


Fig. 856.

Wilder's Operation for Ptosis.

Incision along the supra-orbital margin, *c*; exposure of the tarso-orbital fascia and tarsus by separation of the lower flap. A suture passed into the tarsus at *a*, gathers the folds in the fascia, and is secured in firm tissue under the eyebrow.

ment of the lid after these operations is much more natural than when it is raised by the action of the frontalis muscle, which draws it straight upward, obliterating the natural folds and altering the expression of the face.

In considering the anatomical relation of these two muscles, it is to be remembered that they lie very close together, from their origin in the posterior angle of the orbit to their points of insertion, the levator palpebræ being directly above the superior rectus.

The layer of the deep fascia about the one merges into the fascia surrounding the other, and their tendinous expansions in front are separated only by the conjunctiva. They are innervated by the same nerve, the oculo-motor.

In action, the structures to which they are attached describe the same upward curve; and they are so co-ordinated that one cannot turn the eye upward or downward without the lid following it.

Such considerations prompted Motais to devise the ingenious operation for ptosis that bears his name; and within two months from the time he read his paper on the subject at the annual meeting of the French Ophthalmological Society, in May, 1897, Parinaud presented to the Paris Ophthalmological Society an operation that he had devised, showing that he also had made use of the same principle, although the technic of his operation is quite different from that of Motais.

Naturally, these operations are not applicable to cases of paralytic ptosis in which all branches of the third nerve are involved, as is frequently the case. Neither would they be suitable for cases of congenital ptosis in which a weak upward movement of the eye indicates the possibility that the superior rectus, as well as the levator, is imperfectly developed; although cases have been reported in which there seemed to be an improvement of the working power of the superior rectus after raising the lid by the Motais operation.

Operation of Motais[106].

The operation may be done under cocain anaesthesia. The upper lid is everted and drawn upward by an assistant, who places a sharp hook in the superior border of the tarsus.

Another sharp hook is placed in the upper layer of the sclerotic coat, 4 or 5 mm. above the cornea, with which to draw the eye downward. (It might be safer to use a fixation forceps for this purpose).

A transverse, conjunctival incision, 10 to 12 mm. in length, is then made with scissors, 6 or 7 mm. above the cornea, and from the middle of this a vertical incision in the conjunctiva extending to the superior margin of the tarsus. (Fig. 857, *a, b, c.*)

The conjunctival flaps are loosened and separated, so as to bring the tendon of the superior rectus into view, and beneath it a strabismus hook is placed as indicated in Fig. 858.

The middle of the tendon is then seized with a pair of fine-toothed forceps, about 2 or 3 mm. from the line of insertion, and the middle

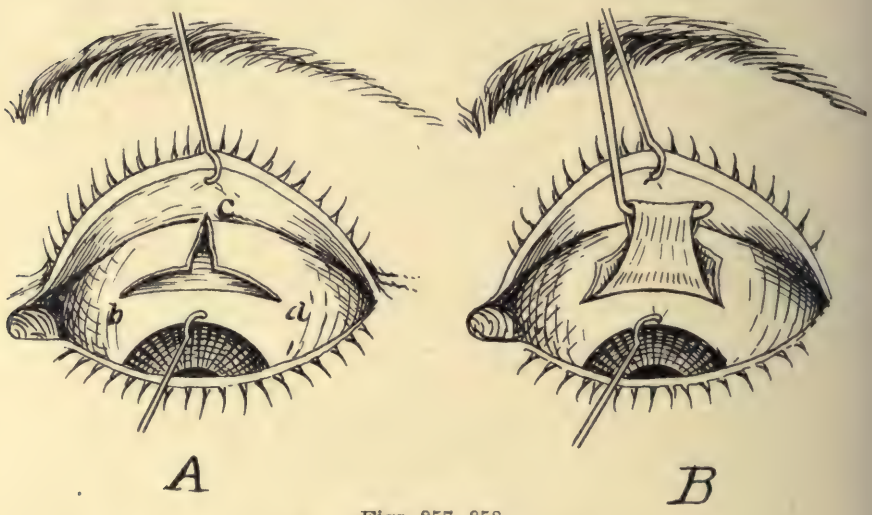
[106]Motais. Opération du ptosis pour la greffe tarsienne d'une languette du tendon du muscle droit supérieur. *Soc. franç. d'Ophtal.*, 1897, p. 208. Also reported, by the same title, in the *Annales d'Oculist.*, *Vol. CXVIII*, p. 5.

fibers are cut for about 3 mm. at the line of insertion. From each extremity of this small, horizontal incision vertical ones are made in the tendon, 10 mm. in length, so that a tendinous flap is made in the middle of the tendon 10 mm. long and 3 mm. wide. (See Fig. 859, *C*.)

The end of this little flap is then held with a broad, conjunctival fixation forceps, to handle it more easily, and at about 3 mm. from its extremity two fine, curved needles, on a double-armed suture, are passed through it ½ mm. from either edge, as in Fig. 860, *D*.

A pocket is then made on the anterior face of the tarsus, extending to within 5 mm. of the lid border, by cutting with scissors the tissues at the extremity of the vertical incision first made. Fig. 861, *E*.

The needles are now passed into this little pocket, and come back



Figs. 857, 858.

Motais' Operation for Ptosis.

A. First Stage. *b*, *a*, transverse incision in the conjunctiva, 7 mm. above the cornea. From the middle of this incision another extends to *c*, at the superior tarsal border.

B. Hook holding up the tendon of the superior rectus

through the tarsus about 2 mm. from its superior border; the little tongue of tendon is drawn onto the anterior surface of the tarsal plate; the sutures are tied on the conjunctival surface.

To avoid accident to the cornea from the knot, the needles may be passed through the skin, to emerge just above the lashes, about 4 mm. apart, where the suture may be tied over a roll, as shown in Fig. 862, *F*.

If the effect on the ptosis is sufficient, the surgical knot in the suture is completed. If the lid is not sufficiently elevated, the little tendinous flap is withdrawn and the loop suture placed higher up; or

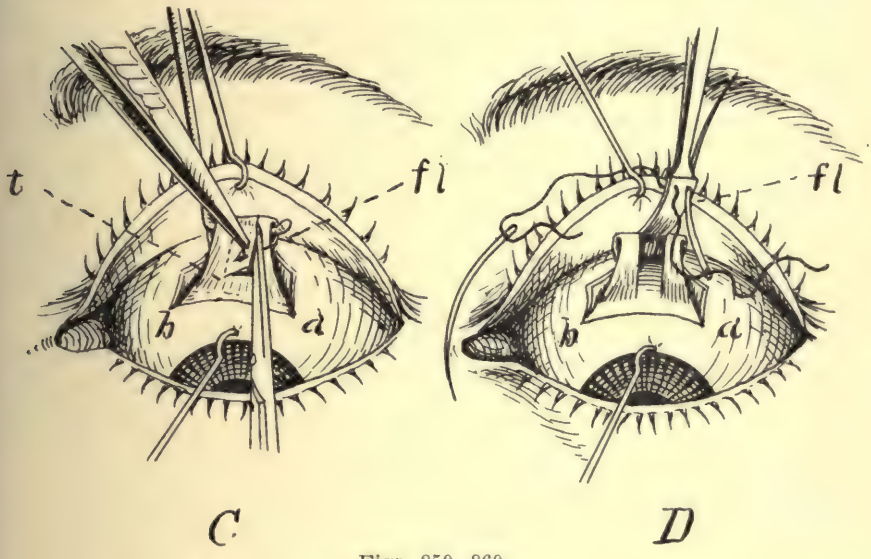
the pocket may be deepened and the little tongue made to take a place nearer the free border of the tarsus.

Two or three points of suture are then placed in the conjunctival wound to cover the new tendon.

Both eyes are closed with a dressing, and the stitches are removed in eight days.

The objection made to this procedure is that a serious vertical diplopia may be caused, because of the inability of the superior rectus to carry the additional weight of the lid and keep up with its fellow of the opposite eye.

This, however, does not seem to be the case, according to the testimony of those operators who have had much experience with the



Figs. 859. 860.

Motais' Operation for Ptosis. Second Stage.

C. Forming the tongue flap, *f. l*, 3 mm. wide in the middle of the superior rectus tendon. Lateral incisions in the tendon are 10 mm. long.

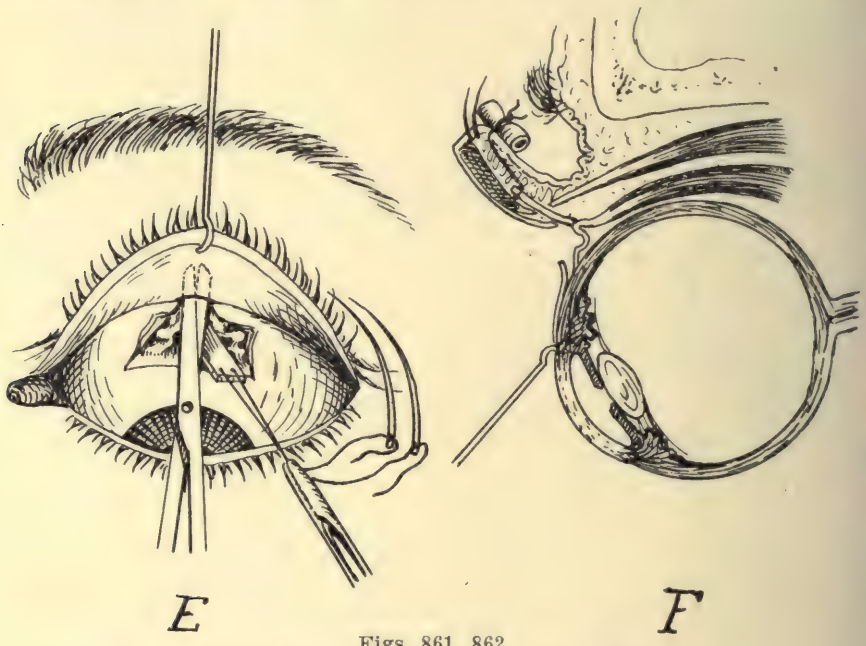
D. Tendon flap, *f. l*, held by a fixation forceps, while a loop suture is passed through it, 3 mm. from its end.

operation, and it is even claimed, as mentioned above, that often a weak superior rectus has developed strength under the additional work thrust upon it.

The diplopia, that may be noticed immediately after the operation, usually disappears, or at most, can be elicited only when the eyes are turned strongly upward. This has been the experience of the author in five cases in which he practised the operation, in three of which the technic was modified according to the suggestion of Shoemaker.

Shoemaker[107] thinks that failure to get the desired result after the Motais operation may be due to the fact that the sutures, if passed through the skin, may attach the tendon flap to the orbicularis muscle and not to the tarsus, as it should be. From the anatomical relation of the parts it is impossible to attach the flap very far below the superior border of the tarsus. To secure an accurate placing of this flap, he sees no objection to an open operation and suggests the following modification:

After preparing the tendon flap in the manner that has been described, the lid is returned to its natural position, and a horizontal in-



Figs. 861, 862.

Motais' Operation for Ptosis. Final Stage.

E. Forming the pocket on the anterior surface of the tarsus, beginning at the upper end of the vertical incision first made.

F. Diagram of the vertical section through the lid and eyeball to show the relation *of the parts* after operation.

cision is made through skin and muscle a little below the superior tarsal border. Dissecting back the upper and lower flaps of this wound exposes the superior border of the tarsus, at the upper edge of which a buttonhole can be made through the fascia and levator tendon communicating with the vertical incision already made in the conjunctiva. Through this little opening, the flap can be passed and fastened di-

[107] Shoemaker. Observations on the Motais Operation for Ptosis. *Annals of Ophthalmology*, Oct., 1907, p. 608.

rectly and accurately in place on the tarsus. To do this the loop on the tendon flap should be placed on its upper surface; the needles then secure a hold on the tarsus, and are brought out through the orbicularis and skin, 4 mm. apart, and are tied over a roll. Two fine sutures unite the skin wound.

The author has followed this technic in three cases, and can testify to the value of the modification.

In addition to this suggestion of Shoemaker, in order to prevent the fine sutures that pass through the tendon flap from cutting loose because of the tension, the author seized the levator tendon and fascia on each side with loop sutures brought out in the skin of the lid above the cilia, after the manner of Everbusch. This gave support to the lid while the tendon flap was healing in its new position.

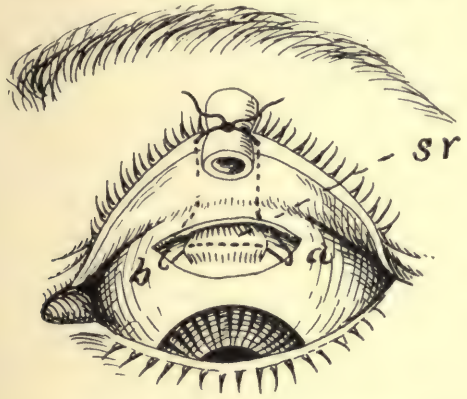


Fig. 863.

Parinaud's Operation for Ptosis.

a, b, incision in the conjunctiva, 12 mm. in length, near the superior border of the tarsus, exposing the tendon of the superior rectus, *s, r*. The suture is passed beneath the tendon, then through the lower lip of the conjunctival wound; then along the anterior face of the tarsus, as indicated by the dotted lines.

Parinaud's Operation for Ptosis[108].

This operation consists in uniting the tendon of the superior rectus with the superior border of the tarsus by means of a loop suture. The lid is everted and the tarsal border is held with a tenaculum or with fixation forceps, and the eyeball is drawn downward with another tenaculum or with forceps. An incision is then made with scissors in the conjunctiva, 12 or 15 mm. in length, near the superior border of the tarsus. (Fig. 863, *a, b.*)

The conjunctiva is separated so as to expose the superior rectus tendon.

---

[108]Parinaud. Nouveau procédé opératoire du ptosis. *Annales d'Oculistique*, 1897, Vol. CXVIII, p. 112.

This is seized with toothed forceps and one needle on a double-armed suture is passed under it, including also the capsule on either side. The needles then pass through the lower lip of the conjunctival wound (to close it), then beneath the upper lip of the wound to penetrate the tendon of the levator and glide along the anterior face of the tarsus, to emerge 7 or 8 mm. apart, in the free border of the lids, just in front of the lashes. They are tied over a roll of gauze with a bow-knot, drawing them sufficiently to raise the lid.

The effect can be increased or diminished at the next dressing. The sutures are allowed to remain for five or six days.

In cases of paralytic ptosis, a portion of the superior border of the tarsus may be excised with curved scissors, to enhance the effect, and this will also facilitate the introduction of the sutures.

SUMMARY.

It will be seen from the number of operations that have been devised for its relief, that ptosis is a condition not easy to remedy.

Of all the operations that have been described those of Motais and Parinaud seem to approach more nearly the ideal, theoretically at least.

As Shoemaker has remarked, the successful performance of these operations amounts to a fixation of the eyelid to the eyeball at a point a little above the insertion of the superior rectus.

In many cases, especially of complete ptosis, it might be a serious question whether the superior rectus could ever adapt itself to the new load. When it does, the ideal result is obtained; that is, the lid is raised so that vision is not interfered with, and follows the movements of the eye upward and downward.

If the superior rectus is too weak to accomplish this, then annoying diplopia would follow, with possibly an apparent downward squint.

It would seem, theoretically at least, in cases of complete ptosis, that a combination of the Motais and Parinaud principle with that of shortening the lid by excision of a strip of the tarsus, after the manner of de Grandmont, in Class III, Group *c*, would be an improvement on each. Or the Motais operation might be combined with one of the deep-suture operations for supporting the lid, and thus a great part of the weight of the lid would be taken off the superior rectus. This could readily be done if the operation of Motais were made by the open method, after the suggestion of Shoemaker; at the same time gathering sutures could be placed in the tarso-orbital fascia, to shorten it and thus help to correct the ptosis. As said before, the Motais-Parinaud principle is not applicable to cases in which the superior

rectus is very weak, as in some cases of paralytic ptosis, or to cases in which this muscle is congenitally defective.

In such cases one would probably have to resort to some operation described in Class II.

When the ptosis is partial, and it can be shown that the levator still has power, an operation of Class III, for advancement of the point of insertion of the levator, may be employed.

Of these the operation of Eversbusch (folding the tendon), of Lapersonne (dividing the tendon and giving it a new point of insertion on the tarsus) and of de Grandmont (excising a strip of the tarsus), are probably the best and the simplest.

EPICANTHUS.

Epicanthus is a congenital deformity in which a fold of skin, with its concavity lateralwards, extends from the side of the nose and partly covers the inner canthus.

In the Mongolian races a slight degree of epicanthus is naturally present, giving to these people their characteristic expression about the eyes.

In the Caucasian race, it constitutes a deformity that may require operation for its correction. It is frequently associated with other deformed conditions, such as ptosis, anchyloblepharon, convergent strabismus, microphthalmus, etc.

The condition may also be hereditary and has been reported as occurring in several generations of the same family.

A mild degree of epicanthus is frequently seen in young children, which may be regarded as temporary, for it disappears with the development of the bridge of the nose. It is unwise, therefore, to operate on very young persons or until it has been made clear that the condition will not disappear of itself. If with the subsequent growth of the child the condition persists, one of the following operations for its correction may be practised.

Von Ammon's Operation[109].

The fact that by pinching up a vertical fold of skin on the nose the deformity will disappear suggested the operation, called by von Ammon "rhinorraphy." (See Fig. 864.)

He pinched up a fold of skin on the bridge of the nose sufficient to uncover the inner canthis, marked out the line of incision with ink and then excised an oval piece of skin. Von Ammon brought the lips of the wound together with surgical pins around which were placed

[109]von Ammon. Der Epicanthus und die Rhinorrhaphe. *Zeitschr. f. Ophthal.*, 1831, Vol. I, pt. 4, p. 533. Also, *Zeitschr. f. Augenheilk. u. Chirurgie*, 1839, Vol. II, p. 110.

figure-of-eight sutures, but in place of these the wound can be directly closed with silk or silk-worm-gut sutures. The resulting scar is a linear one and not very noticeable if healing by primary union follows.

Knapp[110] modified this procedure by cutting out a rhomboidal or diamond-shaped piece of skin; and, to facilitate movement of the skin flaps, he undermined them in order to have less tension on the sutures which closed the wound. Further support was given by the use of a collodion dressing.

Kuhnt[111] modifies the von Ammon method in the following manner: He marks out the oval piece of skin on the bridge of the nose and forehead, but does not excise it, merely abrading it by removing the superficial layers of the skin with a sharp scalpel. He also loosens the skin flaps from the periosteum by a subcutaneous dissection to enable them to move more freely, and then brings the edges of the

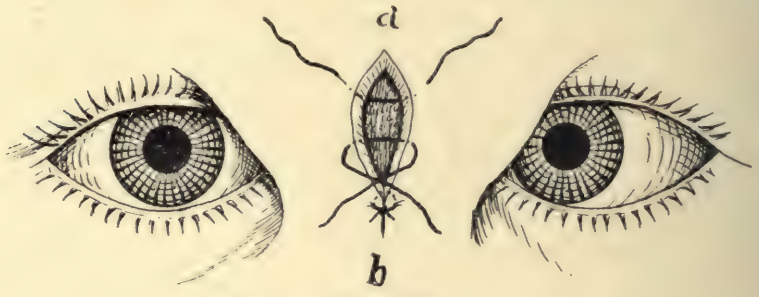


Fig. 864.

von Ammon's Operation for Epicanthus. (Rhinorraphy.)

Fold of skin, *a*, *b*, on the bridge of the nose removed, and the wound brought together with sutures. (*Encyclopédie Franç. d'Ophtal.*, Vol. IX.)

abraded area together with sutures. In this way the skin is folded on itself, thus giving a fuller form to the bridge of the nose. To prevent the sutures from cutting out before union has taken place, several silver wires are placed across at the base of the wound, to reinforce the skin sutures.

Arlt,[112] to avoid the scar on the bridge of the nose that follows as a result of the von Ammon method, suggested removing a rhomboidal or diamond-shaped piece of skin from the side of the nose and the fold of the epicanthus. The long axis is vertical and the wound is

---

[110]Knapp. Epicanthus und seine Behandlung. *Archiv f. Augen. u. Ohrenheilk.*, Vol. III, 1, p. 59.

[111]Kuhnt. Eine kurze Notiz zur Operation des Epicanthus. *Zeitschr. f. Augenheilk.*, 1899, Vol. II, p. 169.

[112]Arlt. Graefe-Saemisch *Handbuch der gesamten Augenheilk.*, Vol. III, p. 443.

of such width that when its edges are brought together by three or four sutures, the fold can be drawn from the inner canthus.

Desmarres[113] followed the same method of excising a piece of skin from the side of the nose and the fold itself. He removed an oval piece of skin, with its long axis vertical and of a suitable width, uniting the edges with sutures. (See Fig. 865.)

Operation of Berger[114].

Instead of excising an ellipse of skin from the side of the nose Berger removes a piece in form somewhat like a triangle, with its base toward the eye and broken by a re-entering angle, as shown in Fig. ——. An incision is made from the upper part of the fold to a point

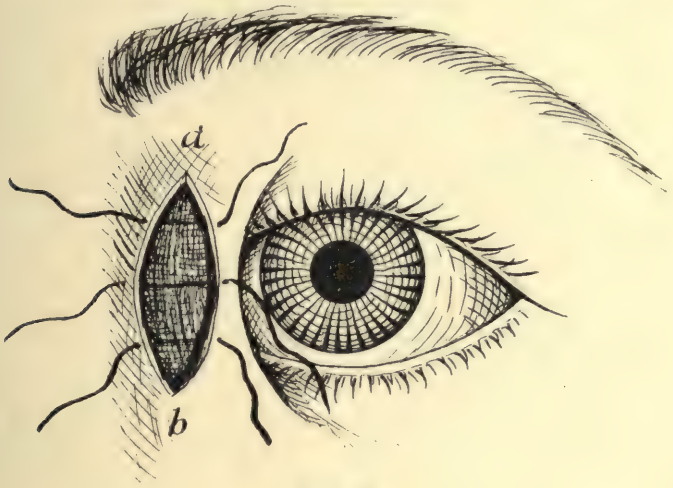


Fig. 865.

Desmarres' Operation for Epicanthus.

An oval piece of skin, *a*, *b*, is excised from the side of the nose, and the wound closed with sutures. (*Encyclopédie Franç. d'Ophtal.*, Vol. IX.)

on the nose in a horizontal line with the inner canthus. This is joined by an incision from the lower part of the fold to the same point on the nose, making a V-incision with its apex on the side of the nose. From the ends of this incision are made two others that converge at greater angle than the preceding, and thus mark out a trapezoidal area of skin, *a*, *b*, *c*, *d*, which is then excised. When opposite points of this denuded area are united by sutures, the fold forming the epicanthus is drawn toward the nose. In this way the center of the fold is drawn upon more than its upper and lower parts.

---

[113]Desmarres. *Traité d'ophtalmologie*, p. 474.

[114]Berger and Loewy. Nouveau procédé opératoire pour l'epicanthus. *Archives d'Ophtal.*, 1898, Vol. XVIII, p. 453.

Operation of Wicherkiewicz for Epicanthus[115].

The account of this procedure, which is the same as that of Berger, was presented at the Ninth International Congress of Ophthalmology held at Utrecht in 1889.

The operation of Berger and Wicherkiewicz is one of the best for this deformity since, by varying the length of the incisions and the amount of tissue excised, the fold can be drawn up at those points where it is most needed. The resulting scar may be well concealed by the mountings of a spectacle or an eye-glass.

Operation of Rogman[116].

Instead of excising any tissue Rogman transposes flaps that are made in the fold of the epicanthus in the following manner:

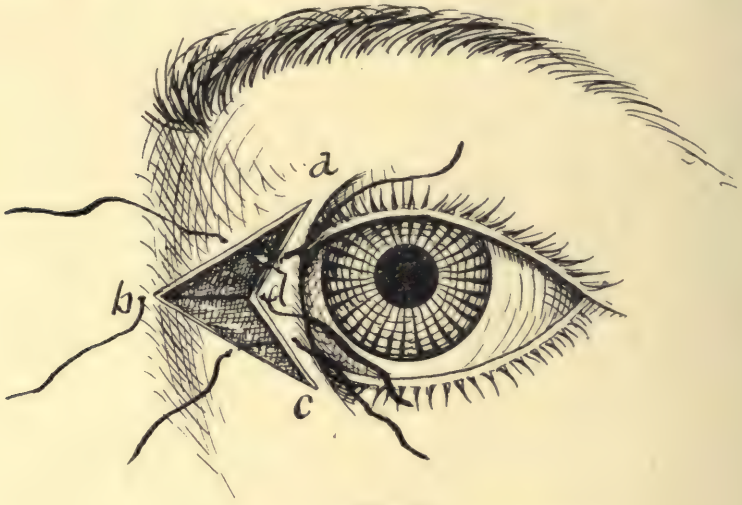


Fig. 866.

Berger's Operation for Epicanthus.

The incision, *a*, *b*, from the upper part of the fold is joined by incision, *c*, *b*.

Two other incisions, *a*, *d*, and *c*, *d*, mark out the area of skin *a*, *b*, *c*, *d*, which is then excised.

The defect is closed by sutures, as indicated.

Between the semilunar border of the fold and the median line of the nose a cutaneous flap is cut in the form of an inverted V, (Fig. 866, *a*). The lower ends of the incisions form this flap extend downward about to the level of the internal angle of the lids. The lateral incision, *a*, *c*, is now prolonged to the edge of the fold, then is directed upward on the ocular side of it in such a manner as to form a second

[115]Wicherkiewicz. Une nouvelle opération d'epicanthus. *Congrès internat. d'Ophtal. d'Utrecht*, 1899. Comptes rendus, p. 583.

[116]Rogman. Nouveau procédé opératoire pour corriger l'epicanthus. *Annales d'Oculist.*, 1904, Vol. CXXXI, p. 464.

V-shaped flap, the apex of which is downward in this case and at a point on the border of the fold of the epicanthus.

There are thus marked out two flaps x and y, the size of which must be proportioned to the degree of subtraction of the skin in the horizontal line that will be necessary to correct the deformity.

After these flaps have been sufficiently freed from the underlying tissues they are transposed and fixed in place with small sutures. This brings the apex of flap y to a point on the side of the nose.

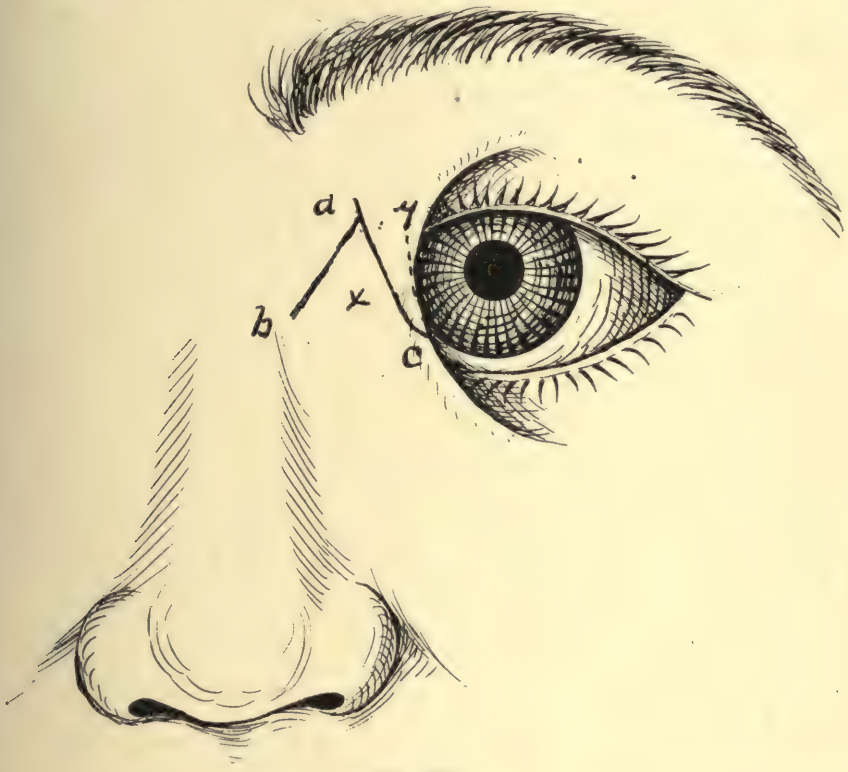


Fig. 867.

Rogman's Operation for Epicanthus.

Incisions b, a, and a, c, mark out the inverted V-shaped flap, x, on the side of the nose.

The lateral incision, a, c, is prolonged to the edge of the fold, then directed upward on the ocular side of it (as indicated by the dotted line) forming an erect V-shaped flap, y, the apex of which is at c, on the edge of the fold.

Flaps x and y are then transposed, and c is fixed at b.

The advantages claimed for this operation are that there is less tension on the sutures, so that primary union is more certainly obtained; and that the effect can be modified at the time of operation by trimming the flaps more or less as may be found necessary.

It is also said to be more suitable for cases of cicatricial epicanthus than operations of the von Ammon class.

In marked forms of epicanthus there is a tightness of the skin over the bridge of the nose that is thought by Foggin to be a factor in preventing proper development of the bones of this part. This he relieves by the following procedure.

Foggin's Operation for Epicanthus[117].

With a narrow cataract knife, the tissues on either side of the nose are separated from the periosteum subcutaneously, the knife entering the skin at a point above the bridge of the nose and between the eyebrows. This subcutaneous dissection is done sufficiently to allow a fold of skin to be drawn up to form a considerable nose-bridge. Sutures are then passed through this fold, from side to side, and tied in the holes of specially shaped lead plates that fit on the sides of the nose and thus hold up the fold of skin that forms the new bridge until it has become fixed.

Within recent years many operators have abandoned operations of this class to make use of *subcutaneous infections of hard paraffin for the correction of epicanthus*, as well as of other deformities of the nose. [See paraffin injection, in the Chapter on Minor Surgery].

LID ABSCESS. FURUNCLE. ANTHRAX.

These conditions will require treatment according to the usual surgical methods for such lesions. When incising the lid tissues for the purpose of removing pus, one should make the incision parallel to the orbicularis fibers, and at the most dependent portion of the abscess, to insure better drainage. A small bit of gauze in the wound, for a drain, may be necessary for a few days.

HORDEOLUM AND ITS SURGICAL TREATMENT.

A hordeolum is a small furuncle that develops in the anterior margin of the free border of the lid among the eyelashes, from infection of one or more of the glands of Zeiss.

It is usually a painful affair, and may cause considerable swelling of the lid. If it does not yield to abortive treatment (hot applications and antiseptic lotions) it should be incised with a very sharp, narrow scalpel at the place where it seems to be pointing, the incision being parallel to the lid border. The subcutaneous injection of a drop of 1 per cent cocain solution into the tissues for anesthetic purposes may be made, but this is usually as painful as the incision. The part is

[117] Foggin. *Ophthalmic Review*, Vol. XX, p. 1,

better anesthetized with a spray of ethylchlorid, with proper precaution for the protection of the eyeball.

Occasionally one or more of the Meibomian glands become acutely infected, producing a condition known as *hordeolum internum*, or *acute chalazion*.

By everting the lid, a yellowish spot, corresponding to the infected glands, may be seen shining through the conjunctiva. If this lies near the lid border, an attempt may be made to express the contents through the orifices of the duct by pressure of the lid between the finger and the thumb nail.

If the case is of any severity, an incision into the little abscess should be made from the conjunctival side, at right angles to the lid border, and therefore in line with the Meibomian glands.

Operations on Chalazion.

Chalazion is a chronic affection of the Meibomian glands, developing gradually into a tumor the size of a pea or even larger. On everting the lid the conjunctiva is seen to be reddened and slightly thickened, or it may appear grayish over the site of the tumor. Small chalazia may not require operation and frequently disappear spontaneously. When the growth becomes large enough to require surgical interference, it may be removed by incision at the lid margin, on the conjunctival surface or through the skin.

According to Ray,[118] the method of removing chalazia through an intermarginal incision was first done by Agnew of New York, who used it regularly at the Manhattan Eye and Ear Hospital. Beard[119] also credits this method to Agnew and recommends it.

It is certainly a valuable method, especially for chalazia that are near the lid border, where they are easily reached by such an incision, and should be more widely known.

Agnew's Operation for Chalazion.

The eye is cocainized, and with a fine hypodermic needle a drop or two of 1 per cent cocain solution is injected into the growth and the tissues at the margin of the lid where the incision is to be made. The injection will be facilitated by the use of a Wilder's U-shaped clamp, placed on the lid over the chalazion after the eye has first been cocainized. After the clamp is fixed, the fine hypodermic needle can be passed between the blades into the tissues of the lid margin. The clamp prevents the cocain from getting into the general circulation and limits its action to the part to be operated on. In two or three

[118]Ray. The Removal of Chalazia after the Method of Agnew, *Amer. Jour. of Ophthal.*, 1888, p. 259.

[119]Beard, *Ophthalmic Surgery*, 1910, p. 213,

minutes the tissues are completely anesthetized, and if the growth is in a part of the lid that can be seized between the thumb and finger, the clamp may be removed; if not, it may be left in place as a means of holding the lid and giving a bloodless field. (See Fig. 868.)

Holding the lid between the finger and thumb so as to give a clear view of the lid margin, a Graefe cataract knife, or a Beer's knife, is then passed through the middle of the lid margin into the tumor. The margin of the tarsus must be accurately split, the incision being of such a length as to include all the diseased Meibomian glands. The knife is then withdrawn and most of the contents of the chalazion follow it, but the lid should still be held firmly between the finger and thumb.

A small curette with serrated edges is then introduced into the

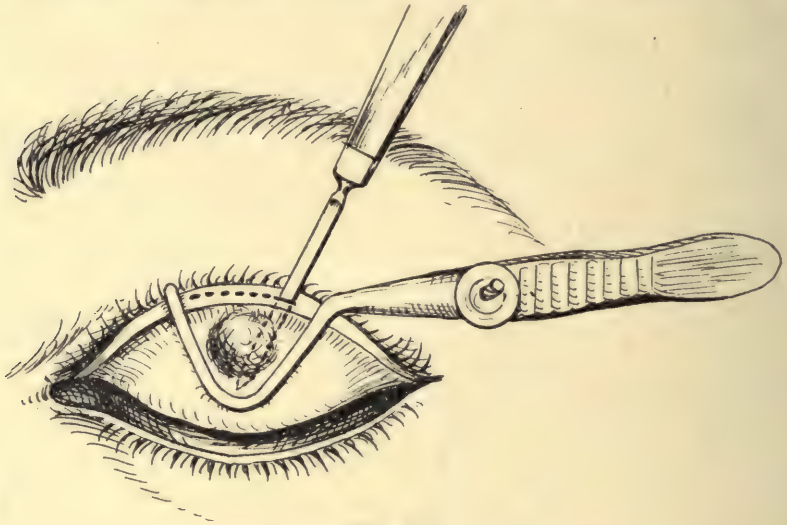


Fig. 868.

Agnew's Operation for Chalazion.

The lid is held in Wilder's clamp for injection of cocain into the tumor and along the edge of the lid. The dotted line indicates the intermarginal incision, made with the clamp in position; or the clamp may be removed after the injection of cocain and the lid held between the finger and thumb.

wound, and the walls of the cavity are thoroughly curetted. During the incision and the curettement, the surgeon's finger and thumb form a perfect guide, as they can feel every motion of the instruments in the tissues.

When all the contents have been removed, light pressure over the cavity is maintained for a few minutes to prevent it from filling with blood. A light pressure bandage is then applied which may be removed the next day.

The operation, when performed in this manner, is painless and no visible scar remains.

Antonelli[120] has recently advocated the same procedure for the removal of chalazion by the intermarginal incision.

Conjunctival Method of Removing Chalazia.

Many operators prefer removing the tumor from the conjunctival side of the lid and this method is applicable if the growth is not too large, that is, does not involve too many of the Meibomian glands, and is situated rather far from the free border of the lid.

In this operation, after cocainizing the eye, a Desmarres lid clamp may be fastened on the lid with the fenestrated blade on the conjunctival side and encircling the growth. A drop or two of 1 per cent cocain solution may then be injected directly into the tumor and around it.

With a small scalpel an incision is then made into the tumor, through the conjunctiva at right angles to the lid margin.

The contents of the chalazion are then removed and its walls thoroughly curetted with a small, sharp spoon, after which the clamp may be removed. A bandage is not necessary.

After such operations, Coggin[121] suggests the application of collodion to the skin over the sac, to cause by its contraction apposition of the walls of the sac, to prevent it from filling with blood.

Cutaneous Method for the Excision of Chalazia.

If the chalazion is large and with thick, firm walls, it may be best to remove it from the cutaneous side. This may also be done with infiltration anesthesia after applying a Snellen lid clamp.

The incision is made through skin and muscle, parallel to the lid border and down to the tumor. The lips of the wound are then retracted, and the surgeon proceeds to dissect out the growth in much the same manner as he would a sebaceous cyst of the skin. In this case, however, the cyst wall is a part of the firm tarsus, and scissors and knife will be called into use. The conjunctiva should not be buttonholed if it can be avoided, but every part of the tumor walls should be removed.

The clamp can then be removed and, after the bleeding is checked, the wound is to be closed with one or two sutures. A light dressing is required for a day or two.

Removal of Meibomian Infarcts.

These are small concretions that form in the Meibomian glands and appear as yellowish spots under the conjunctiva. Usually they

---

[120]Antonelli. Méthode simple, de choix, pour l'opération de certaines formes de chalazion. *La Clinique Ophtal*, 1905, July 10, p. 196.

[121]Coggin. The Use of Collodion in Plastic Operations. *Boston Med. & Surg. Journ.*, May 23, 1895.

cause no irritation, but if they project through the conjunctiva, they must be removed by a tiny incision and scraped out, either with the point of the knife or with a small curette.

In elderly people of a gouty habit, small concretions sometimes form in the glands of the conjunctiva of the fornix and also at the angles of the tarsus that may require removal, which may be done with the point of a cataract knife.

OPERATIONS ON TUMORS OF THE LIDS.

Tumors of the lids seated in the cellular tissues, such as dermoid and sebaceous cysts, etc., may be easily removed by ordinary surgical methods, the incision being made, when possible, parallel to the fibers of the orbicularis.

Small tumors, as papillomata, adenomata, etc., seated on the border of the lid, may frequently be excised without destroying the lid border, if the posterior margin is not involved. The lid margin is split behind the growth, and a V-shaped piece of the skin, including the small growth, is then excised, the lips of the wound being united by fine sutures.

If the growth is larger and involves the tarsus, it may be necessary to remove a wedge-shaped piece from the whole lid, after which the defect must be immediately closed with sutures after the manner described under *blepharoplasty,* q. v.

Large tumors, that involve a considerable part of the skin of the lids, must be removed according to surgical rules for such conditions, and the defect closed by an appropriate plastic operation. (See Plastic Operations on the Eyelids).

Removal of Angioma, Angiofibroma and Lymphangioma.

Tumors of this kind may also be removed by excision, provided this can be done without too much loss of the skin surface. If the tumor is beneath the skin and does not involve it, an incision may be made down to the tumor, which can then be dissected out. The lid clamp will be useful in such cases.[122]

If the tumor is too extensive for excision, one may have recourse to electro-puncture or electrolysis. The positive pole of a galvanic battery, with a sponge or plate electrode, is placed on the face. The negative pole is attached to a needle mounted in a suitable handle. When the needle is plunged into the tumor, the current is turned on, and electrolysis is indicated by the appearance of bubbles of hydrogen gas at the point of puncture. The needle is then withdrawn and in-

[122]Knapp. Zur operativen Behandlung der Gefässgeschwulst der Augenlider. *Archiv f. Augen. u. Ohrenh.*, VI, p. 38.

serted at a different place, and a number of punctures are made at the same sitting. Several such treatments will be necessary, and care must be taken that the punctures are not too numerous, nor too near together, to avoid extensive necrosis. The electrolytic action causes coagulation of the blood in the vessels of the growth, and their eventual obliteration.

PART VII.

CHAPTER I.

OPERATIONS ON THE LACHRYMAL APPARATUS.

By HOWARD F. HANSELL, M. D., Philadelphia, Pa.,
and
JAMES HALL BELL, M. D., San Antonio, Texas.

Surgical Anatomy of the Lachrymal Apparatus—Chemical Composition of Tears—Principles of Surgery of the Lachrymal Apparatus—Operations on the Canaliculi—Atresia of the Canals—Slitting of the Canaliculi—Ligature of a Canaliculus—The Cautery in the Operative Treatment of the Canaliculi—Probing the Naso-lachrymal Duct—Stricturotomy—Bowman's and Theobold's Probes—Accidents of Probing—Causes of Nasal Duct Obstruction—Incision of the Tear Sac—Operations for the Relief of Naso-lachrymal Duct Obstruction—The Use of Lachrymal Syringes—Lachrymal Fistula and Operations for its Relief—The Drill in Opening the Obliterated Nasal Duct—Styles, Solid and Flexible—Lachrymal Bougies and their Use—Congenital Atresia of the Nasal Duct—Excision of the Lachrymal Sac—Indications for the Operation—Technique of the Operation—Extirpation of the Sac, with Insertion of a Prothesis—Obliteration of the Lachrymal Sac—Accidents During Excision of the Sac—Extirpation of the Lachrymal Gland—Surgical Treatment of Dacryops.

SURGICAL ANATOMY OF THE LACHRYMAL APPARATUS.

It is not within the restricted province of this chapter to present a supplement to common knowledge, or to impose on the reader a useless waste of time, by a detailed description of the minute structural anatomy of the *lachrymal apparatus,* which consists, comprehensively to the surgeon, of the lachrymal gland, tubules, Krause's glands, puncta lachrymalia, canaliculi, lachrymal sac and naso-lachrymal duct.

The *lachrymal gland,* an acinous body, lies in the fossa *glandulæ lachrymalis,* a bony depression in the upper anterior temporal angle of the orbit, and measures, in the adult of average size, about 15 millimeters in length, 4.5 millimeters in width and 7 millimeters in depth. In the infant the gland is small, relatively narrow and imper-

fectly developed. It is covered by a thin layer of orbital periosteum, a strong sheet which, attached front and back to the *crista lachrymalis,* ascends to the roof of the orbit, forming a separate and firm covering for the gland. The two sections, *superior* and *inferior,* into which the gland is divided, are in part separated by a tendinous expansion of the *levator palpebræ* muscle.

The *superior* lachrymal gland is the larger of the two sections, occupying the entire fossa, and is supported by trabeculæ from the periosteum. Tears are secreted within the gland, and empty through delicate outlets, three to five in number, measuring half a millimeter in diameter *(ducti excretorii)* which pass between the folds of the inferior gland, from which they receive contributing secretions, and discharge into the upper conjunctival fornix, 4 to 5 millimeters from the superior tarsal border.

The *inferior division of the gland,* smaller and less compact of structure than its superior portion, to the under surface of which it is loosely attached above, its lower surface lying immediately above the fornix, secretes directly into the ducts of the superior gland, and, independently, into the fornix through its own tubules, three to nine in number. The gland is imbedded in a thick layer of connective tissue which distributes delicate septa between its component cells. Authorities give varying estimates of the weight of the gland, ranging from 3.5 grains (Bischoff) to .94 of a grain (Krause).

Microscopically, the gland consists of numerous cells loosely bound together by connective tissue, closely resembling in structure the parotid gland. Each of the component glands is connected with the upper conjunctiva by fine passages lined with flat epithelium. The tubules have thick walls, surrounded by cylindrical albuminous cells, which, in the intervals of secretion, are lessened in caliber, assume a more granular character, and lose their sharp borders. The basal membrane forms trabeculæ, which embrace by their branches the various cells, filling the space between them. Exteriorly, this membrane forms an imperfect capsule and, on the upper temporal side, is united to the periosteum by a moderately strong band, the *ligamentum suspensorium glandulæ lachrymalis.* The lachrymal nerve (branch of the facial) and the ramus zygomaticus (maxillary branch of the fifth) contain motor, sensory and secretory fibres. The sympathetic nervous system is not known to have any influence on the secretion of tears. The fibers are, for the most part, non-medullated and form, on the basal membrane, a network from which fine branches are distributed constructively to another and smaller network among the cells.

Krause's glands, glandulæ mucosæ, loosely situated in the in-

ferior and superior fornices, are similar in structure and accessory in function to the gland proper, and, according to Fuchs, "may be regarded as its ultimate scattered outlying portions."

The *lachrymal points—puncta lachrymalia,*—are the minute palpebral openings of the canaliculi, situated on the free margins of the lids, near the inner canthus. These canals, 6 to 7 millimeters in length, are nearly vertical for 1 millimeter *(pars papillaris),* when they abruptly bend at their vertical bases and converging horizontally, empty into the lachrymal sac separately or by a short common duct. To the nasal side of the angle the canal is widest (1 mm. in diameter). At the opening into the common tube, or into the sac, the caliber diminishes in size to 0.3 of a millimeter. The sinus or com-

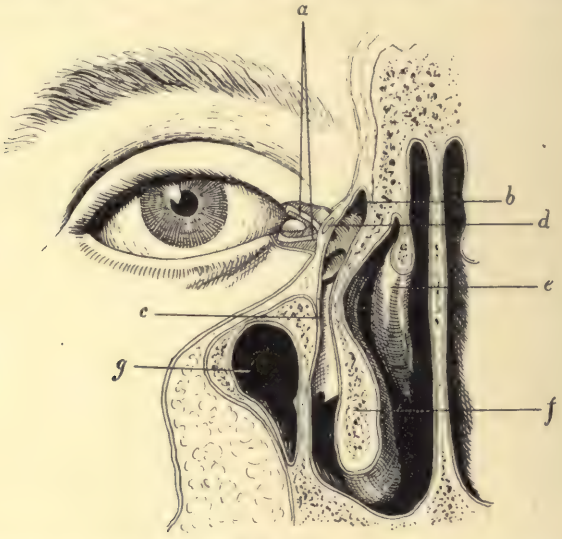


Fig. 869.

The Lachrymal Apparatus. Showing the Nasal Relations. (After Quain.) *a*, The Upper and Lower Canaliculi; *c*, Naso-Lachrymal Duct; *b*, *e*, *f*, Turbinal Bones; *g*, Antrum of Highmore.

mon tube is from 0.8 to 2.2 millimeters in length, and lies beneath the *ligamentum palpebrarum mediale.* Muscular fibers, offshoots from the *orbicularis palpebrarum,* a part of Horner's muscle, surround the duct and pursue a spiral course in the canal proper. The canals are lined with epithelium, flat on the surface, columnar near the basal membrane. It is a mucous membrane similar to and continuous with the mucous lining of the nose and its accessory cavities.

The *lachrymal sac* lies at the nasal end of the canaliculi and superior extremity of the nasal duct, corresponding in form and size to the fossa of the nasal bone in which it rests. It is protected and supported by bone posteriorly and to the nasal side, and is strengthened

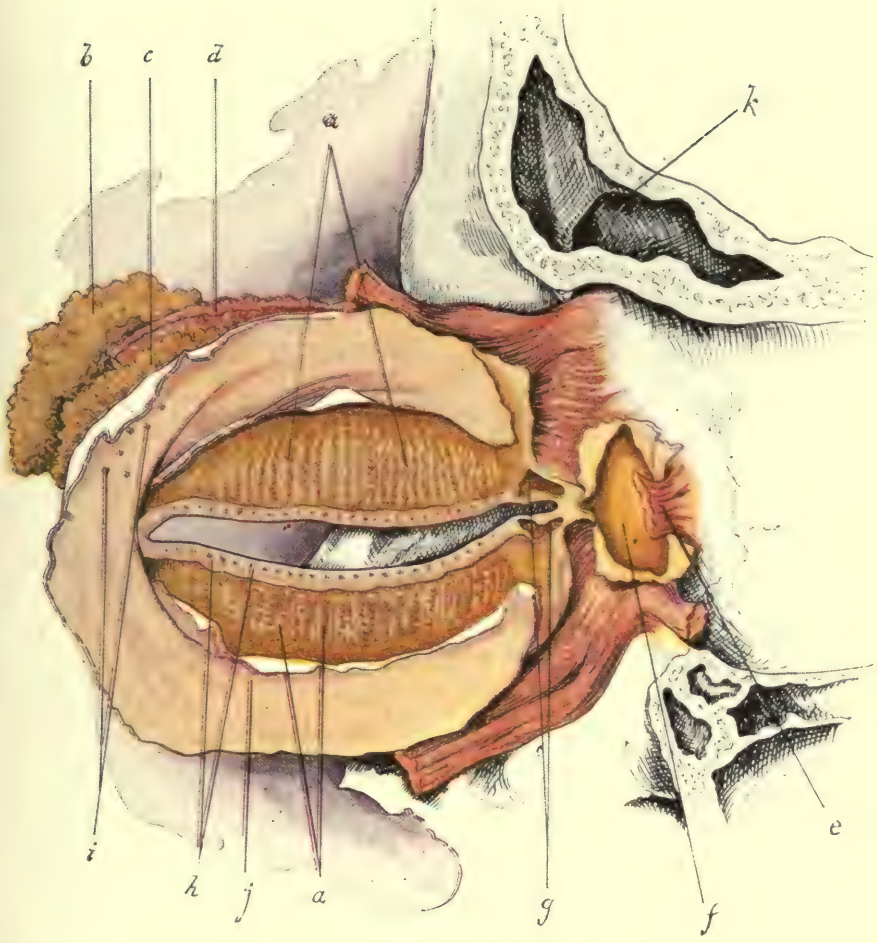


PLATE XIV

Relations of the Lachrymal Sac,

a. Meibomian glands,
b, Superior portion of lachrymal gland.
c. Inferior portion of lachrymal gland.
d. Levator palpebræ superioris.
e. Tensor tarsi.
f. Lachrymal sac.
g. Lachrymal canaliculi.
h. Orifices of ducts of Meibomian glands.
i. Orifices of the lachrymal ducts.
j. Conjunctiva.
k. Frontal sinus.

in front and laterally by ligamentous offshoots from the periosteum, which extend between the *crista lachrymalis*. It is distinctly oval in shape, closely adherent to the periosteum, closed and narrow in its upper part and opens below into the nasal duct, where it is again narrowed. At its widest portion, under the ligament, it is about 8 millimeters wide and, from the fornix to the constriction at the anatomical entrance of the duct, 12 millimeters in length. The canaliculi enter the sac on its lateral side, at the junction of the upper and middle third. It is lined with mucous membrane which, in this situation, is more or less sacculated and contains in its folds, according to Joerss, a few serous glands, which are visible to the unaided eye.

The *lachrymal duct* is narrowest at its origin, measuring about 3 millimeters in diameter. The line separating the sac and duct is not definitely or well marked at the cleft of the lachrymal bone, where it merges into the bony canal.

The mechanism of the drainage of the conjunctival sac is admirably described by Theobald.[1]

"In the first place, the act of winking carries the tears from the general conjunctival surface of the eye towards the canaliculi, causing them to collect in the neighborhood of the puncta; in the second place, it is probable that the pull which the orbicularis muscle, in contracting, exerts upon the internal palpebral ligament is, through the intimate connection existing between the latter and the anterior wall of the lachrymal sac, extended to the sac itself, and that the effect of this is to produce a sort of suction-pump action, which draws the tears through the puncta and the canaliculi into the sac. The tears pass through the duct by reason of gravity, and their descent is facilitated by the elasticity of the lachrymal sac, which causes it, when distended by tears, to contract upon its contents."

The tube is from 13 to 18 millimeters (averaging 15 mm.) in length, and 4 millimeters in diameter. Its diameter may be increased by inflation, as it is surrounded by a network of veins resembling "compressible cavernous tissue" (Haull). Dilation of the veins by pressure upon the mucous membrane lining the bony canal, may cause diminution of its caliber. The lower extremity of the duct opens under the inferior turbinated bone, 10 to 12 millimeters from its anterior border, by a vertical and oblique slit hidden by a valvular fold of mucous membrane (Hasner's valve). The lining membrane is irregularly waved or folded in such manner as to direct all fluids downwards, but contains no actual valves. The true canal, increased in length by a continuation of the mucous membrane along its median wall, is directed downwards, outwards and slightly backwards. This general direction is modified by age, racial and personal peculiarities, and frequently varies on the two sides of the individual face. In narrow nostrils and small openings, the line of direction is downward, backward and inward, while in persons of wide nasal bones

[1]Theobold. *A System of Diseases of the Eye.* Norris and Oliver,

and distended nostrils, the direction is outward from the median line. In young children the canal extends backward at a considerably increased angle. The bones forming the canal are the superior maxillary (major part), lachrymal and inferior turbinal. Its diameter is about 5 millimeters.

Composition of Tears:

		′	″
100 parts	Water	99.06	98.70
	Solid matter	0.94	1.30
	Epithelium	0.14	.32
	Albumin	0.08	.10
	Chlr. Sod., Phos. Sod., Earthy Phos., Mucous, Salt	0.72	.88

(Frerichs).

Alt, who analyzed the tears of a man whose conjunctiva had been almost entirely destroyed by lupus, in which case there could have been no appreciable amount of secretion from the mucous membrane, gives the following analysis in

100 parts	Water	98.223
	Chlor. Sod.	1.257
	Albumin	0.504
	Salts (not Na Cl)	0.016
	Trace of fat	

SURGERY OF THE LACHRYMAL APPARATUS.

The principles which dominate the judgment of the conservative surgeon in general practice, and influence operative interference, are fundamental to the patient's individual welfare and safety. This general dictum applies with equal force to operations upon the lachrymal apparatus. Here, as elsewhere in the great domain of disease, surgery is sometimes meddlesome and restrictive, adds to the patient's suffering, and retards recovery. Non-surgical medication, intelligently addressed to the underlying constitutional dyscrasia will, in many instances, obviate the necessity for operation. For instance, palliative surgical interference, in so simple a matter as the probing or slitting of the canaliculus, or division of a stricture, are painful procedures, requiring frequent repetition, and offer no certain guarantees of a permanent cure. Moreover, a majority of the cases of stricture and dacryocystitis have their origin in disease of the mucous membrane of

the nose, or of its associated cavities, and no ophthalmic surgeon who values his reputation for instructed conservatism, would venture to operate in the absence of definite knowledge respecting the condition of the mucous surfaces of these accessory sinuses. (Bull).[2]

The timely acquisition of such knowledge is not wholly free of perplexities in the frequent experience of the most capable ophthalmic surgeons, for the mucous surfaces of these adjacent cavities with few exceptions are subject to the same morbid processes, and it is sometimes extremely difficult to determine with definiteness the exact cause, location and pathology of the affection under observation. This is particularly true of the earlier manifestations of certain acute inflammatory diseases, and of the slowly growing tumors.

An active inflammation of the lachrymal gland, for instance, does not invariably differ in appearance and symptomatology from the nidus of a beginning orbital cellulitis, and a masked infection originating in the nose or ethmoidal cells not infrequently first displays itself to observation in the lachrymal sac. Brudenell Carter some years ago communicated to Frost (*Ophthalmic Surgery*, Carter and Frost, p. 104) the particulars of the case of a young girl, age 10, from whom he removed an orbital tumor "which had the appearance of an indurated and hypertrophied lachrymal gland." He twice removed this tumor, at intervals of two years, "before it presented the symptoms of a sarcoma." The presumption is that Carter thought he was dealing with either a scrofulous or syphilitic involvement of the lachrymal gland. This case is cited because it is typically illustrative of the importance of an early and accurate diagnosis in all cases of disease of the lachrymal apparatus requiring surgical interference, and gives emphasis to the more modern methods of diagnosis, namely, trained observation of the state of the general nutrition, careful elaboration of the personal and family history, and subjection of all morbid discharges and tumors to microscopic analysis.

Preoperative Measures in Lachrymal Operations.

Sterility of the hands of the assistants, as well as those of the operator, and of all instruments and appliances brought into contact with the parts to be invaded, while of minor importance compared to surgical excursions within the eye ball, should be regarded as an essential feature of all instrumental work upon the lachrymal apparatus. Cleanliness, consistently and thoroughly maintained in all operations, in large measure prevents complications, hastens recovery and confirms the operator's reputation for complete mastery of his subject. Cut-

[2]C. S. Bull. Mixed Streptococcus and Pneumococcus Infection of the Orbit and Adjacent Sinuses. *Annals of Ophthal.*, October, 1808, p. 595.

ting instruments should remain in a 95 per cent. solution of alcohol for at least ten minutes prior to the operation, and all other instruments should be boiled for the same length of time. The face of the patient should also be sterilized. Absolute cleanliness, however, is not always possible in the presence of pus, but even in these not infrequent cases the general principles of aseptic surgery should not be ignored as of little consequence.

OPERATIONS ON THE CANALICULI.

Atresia or *imperforation* of the canal may be congenital or acquired. In the former case, which is rare, the defect is usually associated with other ocular deformities. As there is present in this condition an enophthalmos, or marked anomaly of the ball, and absence of lachrymation, the establishment of an artificial punctum and canal is rarely necessary. The operator is necessarily guided by the anatomical peculiarities in the given case. As a rule the incision is made at the extreme inner angle of the lower lid, its edges everted and held in position by sutures, and communication established with the sac. The opening thus made should be maintained by a lead or silver style, its shoulder fitting into the artificial canal and its shank into the sac and upper part of the duct. A few drops of a 4 per cent. solution of cocain anesthetizes the conjunctiva, and by its use the first step of the operation is begun without distress to the patient. This anesthetic will not, however, appreciably modify the pain of the deeper incision, and in order thoroughly to anesthetize these underlying structures, Schleich's solution should be injected. The stronger anesthetic is rarely employed when the cutting is confined to the region of the canaliculus and is not followed by probing of the duct.

Charles (*Annals of Ophthalmology*, July, 1910) has modified the old operation, suggested by John Green, for curing stillicidium in patients exhibiting a chronic catarrhal conjunctivitis with a tendency to ectropion. He obtains a small and permanent *lacus lacrymalis* by removing the conjunctiva down as close to the tarsus as possible on the temporal side of the punctum. This is accomplished by pressing the lid upward with the finger, so that the flattened blades of the scissors make a fairly deep bite, creating a triangular flap. The flap is then snipped off either by a vertical cut or by an incision similar to the first one, leaving a depression, at the bottom of which may be seen the beginning of the canaliculus.

Imperforation resulting from injuries, particularly in burns and lacerations, demands more extensive and radical measures, the formation of a channel into the sac being, usually, of minor and secondary consideration. The surgeon here, too, must be governed by the nature

and extent of the tissues destroyed, the degree of contraction of the mucous membrane and of the skin, and by the probable character and amount of the resulting cicatrization. If grafting be necessary, the transferred plant should be sufficiently large to allow for future shrinkage to two-thirds of the original size.

Slitting of the Canaliculi.

This minor operation was in 1851 proposed by Wm. Bowman, as a preparatory step to probing the nasal duct. The end sought was to treat the stricture from its natural aperture. When permitted to choose, operators usually prefer, as a matter of convenience, to operate on the lower canaliculus.

The patient, seated in a chair facing a good light, is told to direct his eyes upward and the operator, standing behind, supports the patient's covered head against his chest. With the first and second fingers of the non-operating hand, the lower lid is drawn gently outward to facilitate the insertion of the point of the knife through the punctum and into the vertical part of the canal. The lid is now with increased traction drawn horizontally toward the temporal side, thus straightening the canal and obliterating the minute circular elevations and depressions of its mucous lining. The instrument is next tilted a little below the horizontal line, its point still retained in the opening of the canal. (At this juncture, carelessness or undue haste will almost certainly cause the instrument to be dislodged). By a twisting movement, the knife is now with gentle pressure forced horizontally through the canal toward the nose, and continued until its point is felt in contact with the nasal bone. By slight to and fro movements, the hard surface of the bone may easily be distinguished, or entanglement of the end of the instrument in a fold of mucous membrane determined, by the sensations of touch imparted to the surgeon's hand. If the point be properly inserted, and is not too large, these to and fro movements cause no dragging or pulling of the skin at the inner canthus. The instillation of a few drops of a cocain and adrenalin solution greatly facilitates progress by preventing pain and contracting the vessels of the mucous membrane.

Dean, in a personal communication to the Editor, says: "In operating for stricture of the nasal duct, I have found that it is *seldom necessary to slit up the canaliculus* if one is provided with a very narrow, straight canaliculus knife. I usually open up the passage way somewhat by probing. In dividing the stricture, I generally turn the knife and cut in two or three directions. If the punctum is too small for the entrance of an exploratory probe, I insert the point of a Graefe cataract knife and incise the punctum inwards."

A. D. McConachie, of Baltimore, frequently obviates the necessity of probing by a little operation, original with him in the treatment of epiphora. After splitting the canaliculus, he cuts away its posterior lip down to the level of the floor of the canaliculus, first nicking the posterior lip perpendicularly at its outer extremity, and then with curved scissors shaves the lip off down to the floor. This procedure is especially applicable to cases of eversion of the puncta.

Von Hoffmann[3] proposes a method somewhat similar, particularly

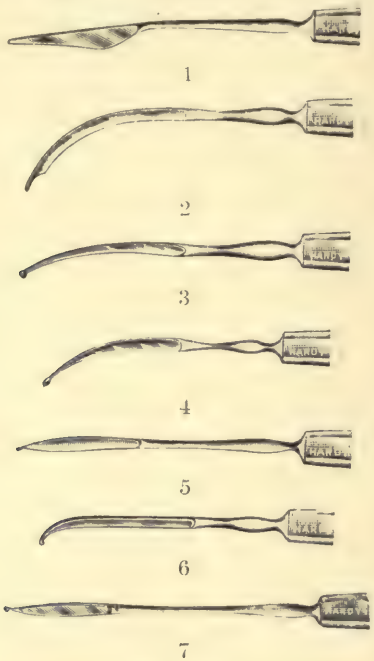


Fig. 870.

Various Naso-Lachrymal and Canaliculus Knives.

1. **Schmidt-Rimpler Canaliculus Knife.**
2. **Weber's Full Curved Canaliculus Knife.**
3. **Weber's Half Curved Canaliculus Knife.**
4. **Bowman Canaliculus Knife.**
5. **Weber's English Pattern Canaliculus Knife.**
6. **Schweigger's Canaliculus Knife.**
7. **Agnew's Lachrymal Knife.**

applicable, he claims to *inversion and eversion of the lower lid, closure or diminution in caliber of the punctum, acquired displacement, paralysis of the seventh nerve, and as a preliminary to enucleation.* He washes out the canaliculus with the Anel lachrymal syringe, and introduces a small Weber knife, as in the Bowman operation. In

[3]**von Hoffmann. Verbesserung der Bowmanschen Schlitzung, *Trans. Tenth Internal. Ophthalm. Cong.*, 1904.**

eversion of the lid, the cutting edge is directed toward the ball; *in inversion,* toward the operator. The incision is made as far as seems desirable, half way to the caruncle, or into the sac itself. The end of the cut marks the site for the removal of a triangular piece of membrane, which forms a new opening into the canal for the escape of tears. At this point the posterior lip of the cut and posterior wall of the canal are grasped by forceps, while the lower lid is drawn down and away from the ball. The first cut, made with the scissors at right angles to the slit and to the outside close to the forceps, is carried the depth required to establish the new opening. The second cut embraces a part of the mucous membrane held by the forceps, varying in size from the head of a pin to that of a small pea or bean. The lid is now allowed to return to its original position, completely hiding the denuded portion.

This device will occasionally be found sufficient to relieve the epiphora when due (as it rarely is) to blocking of the canal from a collection of microliths, or broken down epithelium. The canaliculus knife (Weber's preferably) is introduced as already described, except that the twisting movement of the blade must be limited to less than a quarter turn. Its cutting edge is directed upward and slightly toward the ball, thus forming a gutter for the reception and discharge of lachrymal secretions. When the point touches the bone at the inner extremity of the canal and is not, by gentle retraction and advance, caught by a stricture, or fold of the mucous lining of the canal, it is safe to assume that the canal is properly established.

W. H. Snyder[1] operates for *badly placed eversion of the lids* by freshening the edges of the slit canaliculi and suturing them. The canals are obliterated in a few days. A new passage (which should be kept open with a probe for a couple of weeks) is then made obliquely from the conjunctiva to the lachrymal sac, so directed that its lips are as nearly as possible in contact with the globe. So placed it drains remarkably well. He elevates the handle of the canaliculus knife, firmly holding the lid, and divides the upper inner wall of the canaliculus from the punctum to within 2 millimeters of its opening into the sac. This is accomplished when the handle reaches the supraorbital notch. In many cases, it is not necessary to cut the canaliculus more than 1½ millimeters, thus confining the incision largely to the punctum, the blunt point of the blade reaching the nasal bone without further cutting or elevation of the handle. Care should be taken not to wound the lid, an accident that may readily happen to persons with prominent eyes. The upper lid is easily drawn out of the way by a finger of the right

[1]Snyder. A New Operative Procedure for Correction of Badly-Placed Canalicular Cuts. *Ophthalm. Record,* June, 1904, p. 256.

hand. As a precaution against making a false passage, a conical sound, or the dilator of Galezowski, may be introduced and the canaliculus well stretched for a few minutes preceding the introduction of Weber's knife. Withdrawal of the knife is attended by moderate, temporary pain and slight hemorrhage. If the incision be not carried beyond the caruncle, it forms a perfect gutter for the passage of tears, and, opening slightly inward to the globe, presents no deformity.

Slitting of the upper canaliculus may be compulsory in congenital anomalies or traumatism (burns, cicatricial formations, etc.) involving the inner portion of the lid. Its surgery is essentially the same as described for the lower canal, and does not require special elaboration.

For the *cure of stricture, occlusion* or *absence of the punctum,* to clear the canal of exudative deposits, to promote easy access to the lachrymal sac, or to pave the way for the efficient treatment of disease of the sac or duct, surgical interposition may be required. It should not, however, be rashly undertaken in acute inflammation of the sac tubercular involvement of the bones, or in complete stenosis of the duct.

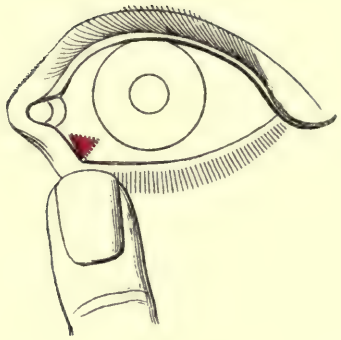
Ligature of a Canaliculus.

To obliterate the punctum or canaliculus *temporarily* preparatory to intra-ocular invasion in purulency of the sac, or *permanently* in serious or malignant orbital disease, a suture is passed through the lid, 2 millimeters below the margin, between the punctum and the caruncle, and tied. As both canals must be tied, two sutures may be used, or both canals be included by a single suture.

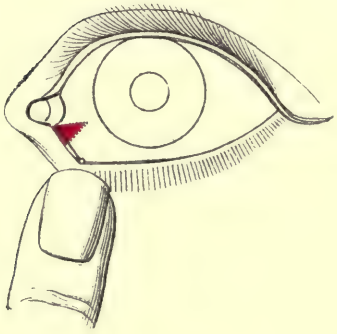
Beard's technique preparatory to extraction is thus described:

"The time for the operation is the moment preceding the extraction, and it is performed in the following manner: The contents of the sac and canaliculi are thoroughly expressed. The canal may be syringed with a mild antiseptic wash. Casey Wood mentions having previously injected a solution of argyrol, letting remain what would. Two number one Bowman probes are passed into the sac, one through the upper, the other through the lower canaliculus, and held there by an assistant, as guides. They are held somewhat apart, so as to mark the outermost bounds of the canal above and below. A half-curved needle of small dimensions, armed with number two or number three silk thread, is passed in just below the lower probe, and close to the inner canthus, deep enough to clear the union of the canaliculi at the back, and out just above the upper probe, and securely tied. The fibers of the tarsal ligament are necessarily included, and so much the better, as they assist in the compression of the canal. Braided silk thread boiled in paraffin makes a more suitable ligature than cat or silkworm gut, as it is not so harsh and irritating to the skin, and does not work loose. It is best not to leave it double, that is, both strands in, unless it is doubled and twisted after having been put through the eye of the needle. The ligature may be removed in four or five days, or after sufficient healing of the corneal section. If there is any resulting stenosis of the canal, which is not likely, it can be relieved afterward by dilating the punctum and passing a small, olive-tipped probe."

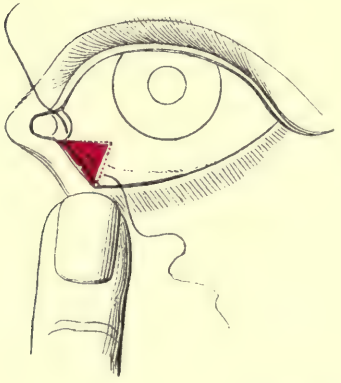
The suture is to be removed after the corneal wound has healed.



A. First Step.



B. Second Step.



C. Third Step

PLATE XV

Hoffmann's Improvements on Bowman's Operation of Slitting the Canaliculus.

The canaliculi may *temporarily be closed by the galvanic cautery,* as suggested by Haab,[5] Peschel,[6] Bettremieux,[7] and others. The cautery is applied for a moment to the puncta. The passage is later re-established by the aid of a sound.

To *permanently close the tube, the cautery* must be carried into the canal 5 millimeters or more, and allowed to remain until the work of destruction is assured.

Probing the Naso-Lachrymal Duct. Divulsion.

Effectively to pass a probe into and through the duct, in the presence of disease or stricture, slitting of the canaliculus is, with rare exceptions, a preliminary necessity. In a subject with a large punctum, an easily distensible canaliculus, or a lid large enough to allow of considerable retraction, it may be avoided. Such cases, however, are rare.

The experience of Ziegler, who forcibly dilates both canaliculus and duct, generally under local anesthesia, for the cure of nasal duct obstruction, is worthy of consideration. He uses a large-sized, pointed

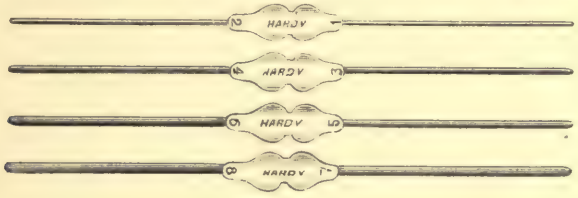


Fig. 871.
Bowman's Naso-Lachrymal Probes.

probe and generally finds one, or, at most two, divulsions or probings sufficient.

The patient is directed to raise the eyes, and the lower lid is then stretched towards the temple, which removes, as elsewhere stated, all folds in the mucous lining of the canal. The probe is now passed horizontally into the sac. Upon touching the inner wall with the point of the probe, its handle is elevated to a point opposite the supraorbital notch, an angle of about ninety degrees, at which position the lower end of the instrument will in the majority of instances, be directed to the furrow between the cheek and the nose. The lid is then released and allowed to return to its natural position. The probe should nearly as possible be curved in correspondence with the direction of the canal. Prominent eye brows must be stretched upward, out of the way of the probe. With its finger-plate directed forward, the lower end of the probe is *gently* forced into the opening of the duct. Should the

[5]Haab. *Beiträge zür Augenhlk.*, Heft III, 1891.
[6]Peschel. *Deutsch. med. Wochenschr.*, 1906-12.
[7]Bettremieux. *Jour. d'Ocul. du Nord de la France*, Fevrier, 1893.

lid be dragged by the movements of the probe, it is evident that its end has been caught in a fold of mucous membrane, and is not properly engaged in the duct. The handle is purposely held loosely, so that the direction of the point may be instantly changed to free it from entanglements, or to alter its direction. When the point is once properly engaged in the duct, the probe remains in position without support. The upper terminus of the duct, it should be borne in mind, is its narrowest portion, and indicates the usual location of the stricture. The probe is advanced by gently graduated pressure until its finger-plate is on a level with the lower margin of the brow, its lower end touching the sensitive

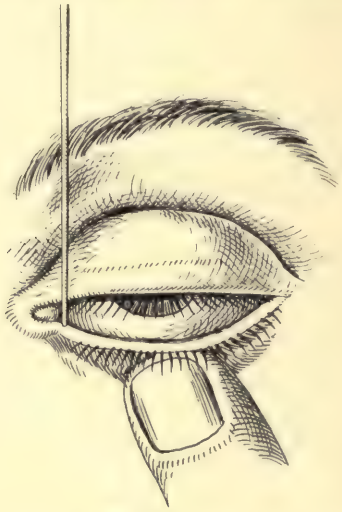


Fig. 872.

Vertical Introduction of the Canaliculus Probe or Dilator Into the Punctum. Slight Eversion of the Lid, for a Better View of the Punctum, is Obtained by Drawing the Former Down and Out. (Meller.)

floor of the nostril, where its further progress is checked. The stricture may, of course, be found in any part of the duct, and when the operator encounters an obstruction, caution and gentleness must be exercised to avoid the creation of a false passage through the mucous lining (an accident likely to happen to a careless or inexperienced surgeon). The probe, in this event, is slightly withdrawn, its proper direction again determined and the advance continued. There is less danger of making a false passage when a large or moderate sized probe is used. Bowman's number 4, 5 or 6, for instance, is less likely to become entangled in folds of the mucous membrane than a number 2.

After insertion, the probe is allowed to remain in position fifteen minutes. It is then slowly and cautiously withdrawn. The operation should be repeated every day, or every second day, gradually increas-

ing the size of the probe, until the duct remains well opened. The intervals of insertion may then be lengthened by a week or two, but should not be wholly discontinued until the duct is permanently established.

Self-Probing of the Nasal Duct.

In tendencies to rapid or repeated recontraction of the canal, not so frequent since the general abandonment of small probes in initiatory work, the plan of instructing the patient to pass the probe or style, to be worn through the night, as suggested by Benson, still has a restricted range of practicability.

As Casey Wood[8] also points out, while the patient not uncommonly gets great relief from the operation and the subsequent probings done by the surgeon he often objects to the discomforts, loss of time, inconvenience and pain of the post-operative procedure and abandons the

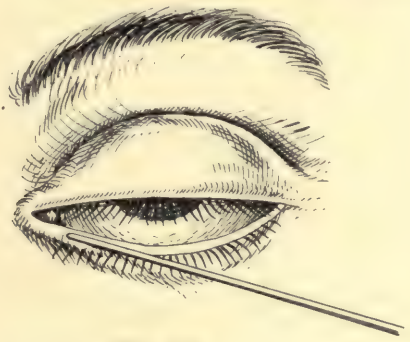


Fig. 873.

Introduction (second step) of the Canaliculus Probe, Dilator or Knife Point into the Lachrymal Sac. The lid is still drawn out with the finger, while the instrument is brought from the vertical to the horizontal position and the point pushed towards the nose. (Meller.)

treatment. In that event the stricture again slowly closes, purulent collections once more stagnate and collect in the obstructed duct and sac, and the last state of the patient is worse than the first. To avoid this unhappy conclusion Wood *teaches the patient to introduce his own probes.*

As soon as the soreness following the slitting of the canaliculus and the nasal stricturotomy has passed the surgeon places the patient before a small mirror and instructs him in the method just described. As a rule the invalid declares that it will be impossible for him (usually *her)* to learn and practice the various steps of the procedure but in the great majority of instances a few lessons suffice. Although the process is awkward for the first few sittings, the difficulties are soon overcome.

[8]**Wood (and Woodruff).** *Commoner Diseases of the Eye,* **3rd Ed., p. 355.**

Then, the patient, having her own probes, cocain, etc., at home, makes daily, bi-weekly or tri-weekly introductions, and is independent of the surgeon and is not affected by the dozen or more influences that might keep her away from the oculist's office or dispensary.

Even the irregular introduction of probes is fatal to a cure of nasal duct stenosis because the crux of the plan is the regular, continuous, uninterrupted opening of the duct for many weeks or months.

Carried out in this way (with an occasional visit to the surgeon), the plan of treatment is rational and successful and may be persevered in for a year or more or until the structure is permanently open.

Stricturotomy.

Division of a stricture preliminary to treatment, is preferred by many surgeons. A Weber's knife is introduced, and its cutting edge

Fig. 874.

A Bowman's Probe in Place after Passage along the Canaliculus into the Sac and Nasal Duct. The point of the probe is in the inferior nasal meatus; the middle of the small plate on a level with the eyebrow. (Meller.)

used instead of the probe. Immediately after the reduction of the stricture by slitting a large probe, number 8 or 10 Bowman's, or Ziegler's, is inserted into the canal. Subsequent treatment is essentially the same as that just outlined.

The *objections* urged with greatest cogency against cutting the stricture, are based on the belief that cicatricial contraction is greater than by the divulsion method, and that the old stricture is more likely to reform and new ones occur. This is a debatable question. The cutting operation certainly facilitates subsequent probing, is more rapidly curative, and does not, in our opinion, sufficiently exaggerate the tendency to recurrent cicatricial formation or contraction to justify opposition to its employment.

Theobald's Probes.

Theobald,[9] in 1877, measured a large number of nasal ducts in the dried skull and cadaver, with a view of determining their average size. As the result of these measurements, he devised a series of probes ranging in size from 1 to 16, the smallest size, number 1, having a diameter

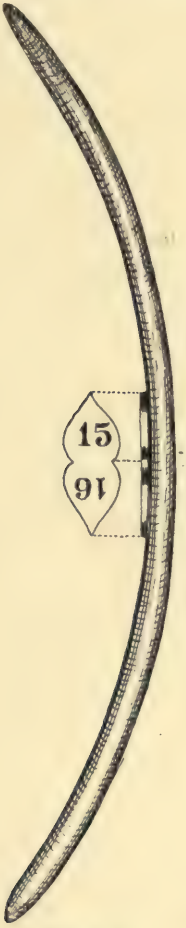


Fig. 875.
Theobald's Lachrymal Probes.

of 0.25 millimeter, and each increasing in size 0.25 millimeter, the largest size, Number 16, having a diameter of 4 millimeters

These probes, now very generally employed, answer every purpose. He considers the best method of treating stricture is by thorough dilatation with large probes, which, he affirms, yield by far the best re-

[9]Theobald. *Prevalent Diseases of the Eye*, Fig. 58, p. 141.

sults. This opinion is very generally shared by ophthalmic surgeons. The writers recommend the use of 4 per cent. cocain solution, or 1 per cent. solution of holocain, alternating with instillations of a solution of adrenalin, 1 to 1,000, previous to the operation. If a stricture be encountered too firm to overcome by a Theobald's probe, a straight, sharp pointed probe should be substituted, and the obstruction penetrated by a drilling motion.

Donovan (p. c.) recommends that the probing be commenced with one of the smaller Theobald probes, and the size of the probe increased to number 12, 13 or 14, at the first sitting. "When there is," he affirms "a history of long previous treatment without improvement, I increase the size of the probe until I feel a slight cracking of the bone." After the third sitting, he uses a probe two sizes smaller, repeating the probings with this number until the canal remains free.

This method is too extreme, painful and possibly injurious to the soft structures, it seems to us, to win popular approval.

The *accidents most likely to occur in either probing or slitting* for relief of stricture of the nasal duct are injury to the mucous membrane tearing or cutting it with the point of the instrument, and the consequent creation of a false passage. This accident is likely to happen when one, not sure of the position of the instrument, drives it with unwarrantable force. The misdirected opening usually lies under the membrane and against the bone of the canal on its inner side, extending through the orbital floor, or perforating the lachrymal bone. Or the instrument, having passed safely into the duct, may pierce the lining separating it from the periosteum, and descend into the nostril below the inferior turbinated bone. These accidents lessen the caliber of the anatomical passage by the formation of cicatrices and cause, rarely, a periostitis. When the bones are not diseased, the creation of an artificial opening is properly attributable to ignorance, inexperience or carelessness. In advanced necrosis, however, it is not always possible to avoid making a counterfeit canal into the nose or antrum through the lachrymal or superior maxillary bones.

The *causes of obstruction of the nasal duct* are to be found, in the majority of cases, in disease of the nose or accessory sinuses. Traumatism and structural alterations at the inner canthus from malignant disease are likewise contributing agencies. Meyer[10] examined sixty-five cases of epiphora and dacryocystitis and, in recording their etiology, ascribes fine mechanical obstacles to the passage of the tears, narrowing of the duct, enlargement of the lower turbinal, inflammatory affections of the nose extending by continuity through the nasal duct, and

[10]Meyer. Nasale Ursachen und Behandlung der Erkrankungen der Tränenwege und der Bindehaut. *Zeitsch. für Augenhlk.*, 1909, XXI, p. 124.

specific infection of the canal, as the most frequent causes of the disease.

Incision of the Tear-Sac.

This operation was first described by Petit.[11]

To open the sac from its cutaneous surface for the purpose of giving exit to pus and to establish drainage in acute dacryocystitis, the lower lid is stretched toward the temple, as when a probe is introduced. A sharp, pointed, small bistoury, its cutting edge downward and slightly outward, is thrust through the center of the swelling and all tissues, down to the median wall of the sac, are divided. The normal topography of the parts is much altered in acute diseases of the sac, and the points anatomically used as guides cannot be relied upon. Exit of pus affords positive evidence that the sac has been tapped, but the surgeon should not be satisfied with the small opening necessary to confirm the diagnosis. The knife, having *touched* the median wall of the sac, should be pressed downward, dividing the swollen tissues for several

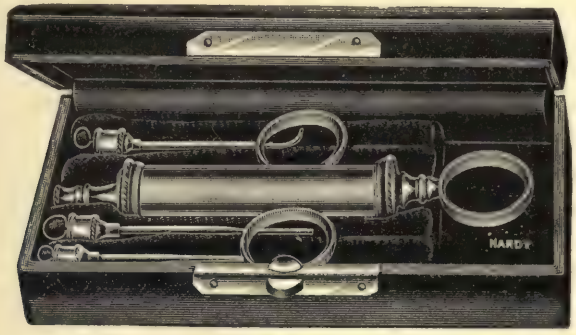


Fig. 876.
Anel's Syringe for Irrigation of the Naso-lachrymal Duct.

millimeters, and so establish an opening large enough for the insertion of a drain—rubber tube or iodoform gauze. The rigidity of the tube sufficiently supports it in position; the gauze is pushed into place with a probe. Before the insertion of a drain, the sac and its adjacent tissues should be freely washed out with an antiseptic. After the drain is in place, hot bichloride dressings, repeatedly applied, will encourage discharges from the wound and aid in controlling the inflammation. The operation is a painful one, but so soon executed that general anesthesia is exceptionally necessary. However, when the operation is incomplete without division of the canaliculi and the passage of probes, anesthesia by ethyl-chloride, or nitrous oxide gas, is advantageous.

[11] Petit. *Mémoires de l'Academie des Sciences*, 1734.

Hemorrhage, likely to be profuse, is not harmful. Local depletion accelerates the cure.

OPERATIONS FOR THE RELIEF OF NASO-LACHRYMAL DUCT OBSTRUCTION.

The Use of Lachrymal Syringes.

In acute and sub-acute cases, permanent changes in the sac and duct may be prevented by systematic cleansing with antiseptic and astringent solutions, injected by Anel's lachrymal syringe. The canaliculus is split, as in the preliminary described for the passage of probes, and the canula inserted as far as the wall of the sac, brought to the vertical position and the fluid injected. Too much force should not be employed, otherwise the fluid may be driven out through the upper canal, or a false passage created, with its attendant injurious complications.

Lachrymal Fistula and Operations for Its Relief.

Through carelessness of the patient, or indifference of the medical attendant, the abscess is often allowed to open spontaneously, forming a fistula through which pus and tears escape and discharge into the adjacent tissues, enlarging the necrotic area and complicating recovery. In mild cases, slitting of the canaliculus and frequent passage of probes, will bring about a cure. In more aggravated involvements of the parts, the fistula must be excised, the exposed tissues thoroughly cleaned and closed by sutures; or the fistula enlarged, cauterized and treated as an open wound.

Numerous methods have been proposed for the cure of fistula by operation. Deutschmann inserts a probe into the fistula, then excises the tissues around the probe, from the mouth of the opening down to the sac. If the sac is diseased, or the duct closed, the sac should be excised at the same time. Moretti[12] introduces to the strictured point, through an opening made directly into the sac, a probe with a platinum tip. This tip, brought to red heat by the current, cauterizes the stricture and frees the canal. In Luedde's[13] case of lachrymal fistula of three years' standing, following traumatism with impermeable stricture of the lachrymal duct, a cure was brought about by the establishment of a false passage between the upper and lower extremities of the duct.

O'Kunueff first removes the anterior third or half of the inferior turbinal to expose the nasal opening of the lachrymal canal. He next frees the canal by introducing one branch of a special scissors-forceps, cutting the bony wall with the other blade. This operation is contra-in-

[12]Moretti. *Recueil d'Ophtal.*, Sept., 1908.
[13]Luedde. *Am. Jour. of Ophthalm.*, April, 1908.

dicated in bone lesions, abundant purulent secretions, ectasia of the sac, and in extensive obliterative changes of the mucous membrane.

Drilling the Bony Obstruction of the Nasal Duct.

The old method of perforating the bone and fitting a probe or style into the canal to retain its caliber, in vogue until the second half of the eighteenth century, has been recently modified by L. E. Schoch, of Shamokin, Pa., (p. c.) who describes an operation performed by him on a patient:

"I slit the canaliculus, and entered a small drill into the canal as far as the nasal wall, then raised the drill in the same manner as in passing a probe, and milled it between my thumb and finger, holding the drill on a line that would bring the point into the nostril. This line angled at about 75°. With a little pressure and milling, I soon made a passage into the nose almost at the opening of the original tube. After making sure that I had pierced the bone and reached the nostril, I examined the latter and found the point of the drill resting on the nasal floor. I removed the drill, inserted a Bowman probe and let this probe remain for a few days, instructing the patient to move it up and down slightly, and also to rotate it by gentle twisting. In this way, after two weeks, the new canal around the probe became healed. The probe was then removed, to be replaced at intervals of a few days. Afterwards, I inserted a silver tube, and had the patient wear it for some months, using ordinary eye washes, and occasionally syringing the canal. Some years ago I had a letter from this patient, stating that the new canal had remained patulous, and had never given any trouble. This was about fifteen years ago, and, up to the present writing, I have not heard that the opening has closed. The instrument I used was a steel wire cotton applicator, seven inches long including the handle, the size of a number 4 Bowman lachrymal probe, filed flat on three sides three-fourths of an inch from the point."

The Use of Styles, Solid and Flexible, in Nasal Duct Obstruction.

It occurs in exceptional cases that repeated probing is impracticable. In this event, excessive lachrymation may be relieved, and the canal held open by the introduction of a style. Permanent recovery from stricture is less assured by this method of treatment than by incision and probing, or probing without incision, and authority for its use hinges on the patient's inability to consult the surgeon at necessary intervals, or refusal to submit to repeated probings. But, as probing is always more or less painful, the surgeon not invariably skillful, or the patient able or willing to continue treatment under his personal supervision, or cannot be taught to introduce his own probes, the wearing of a style may, under these varying conditions, possess distinct advantages.

Theobald[14] asserts that more than a hundred years ago, 1781, the plan of introducing a hollow tube of gold or silver into the nasal duct was proposed by Wathen, of England. Ware suggested the temporary use of nail-headed styles, introduced by incision into the lachrymal sac.

Beer employed catgut cords of different sizes, a fresh part of the

[14]Theobald. *Reference Handbook of the Med. Sciences*, p. 397.

cord being pulled into the tube each day. Mejan used, instead, meshes of silk threads.

Blizzard filled the sac with quicksilver, expecting the obstruction of the duct to yield to the force of gravity imposed by its weight. His reasoning was sound, and the method might profitably be employed in exceptional cases. Burton Cooper,[15] of Bath, England, suggests silkworm gut.

John Green urged, some years ago, the employment of leaden styles. The advantages, he claimed, are that the leaden style is easily introduced and yields, without undue pressure on the parts, to facial peculiarities.

The consensus of enlightened opinion remains strongly affirmative of the conviction that treatment by knife or probe, under the direct care of the surgeon, affords the surest means of relief. No method of treatment thus far discovered relieves the medical attendant from close personal supervision and responsibility in these cases. For it should not be forgotten that patients as a rule are uninstructed, and that it is not possible, in the available limits of the surgeon's time, to impart to his subject precisely the size of the style to be employed, how it should be introduced or the length of time it should be worn. These are questions for the surgeon, and not the patient, to determine, and upon their intelligent solution, the success of treatment largely depends.

Moulton [16] has called attention anew to the *value of the leaden style* as a means of causing, by pressure, absorption of the hypertrophied tissue. He prefers lead because it is pliable, adaptable, impervious to the secretions, and easily obtained. (Ziegler, on the contrary, claims that lead is too soft, and to remedy this defect, adds an alloy of tin). Moulton's style is slightly smaller than the probe last introduced, thus enabling the patient to wear it with comfort, and still have slight pressure exerted on the walls of the canals in the intervals of the use of probes. He says three sizes of leaden wire may be obtained, 1, 1½ and 2 millimeters in diameter, respectively. One end of the style is bent at an acute angle, and projects from the canaliculus in order to prevent the wire from dropping into the duct, and also to provide a handle by which it may readily be removed.

In an obstinate case of dacryocystitis in a child, J. C. Berry[17] successfully employed a *seton*. We quote his experience:

"The child was five years of age, and had profuse purulent discharge from both lachrymal sacs from a week after its birth. He had received faithful treatment at different times from two competent oculists who evi-

[15]Cooper. *Ophthalm. Review*, Jan., 1907.
[16]Moulton. The Treatment of Strictures of the Nasal Duct with Lead Styles. *Trans. Sec. Oph. Am. Med. Assoc.*, 1908, p. 323.
[17]Berry. *Bost. Med. & Surg. Jour.*, April 29, 1909.

dently believe in the use of the lachrymal probe; for, as I examined the enlarged canaliculi, I found them so dilated as to receive a number 8 probe, which literally fell to the bottom of the canal. When inserting a probe for the first time, it is my habit to throw a strong light into the nostril, well dilated, and see if I can discern the tip of the probe (frequently possible in adults), or, if not visible, then to seek to touch it with a nasal probe. In this case, I could do neither. Forcing the lachrymal probe well downward and forward, I finally succeeded in bringing its tip within my field of vision, when I found it to be covered by a tough membrane, the lachrymal sac thus being impervious; while in the opposite nostril, the anterior end of the lower turbinal was firmly adherent to the wall, thus concealing everything in this nostril and rendering necessary the removal of the anterior portion of the lower turbinal. This was done at once, and brought plainly into view a similar membrane covering the lower end of this canal. With a pair of Hartman's cutting-edge forceps, I seized and took away that portion of this membrane covering the end of the lachrymal probe, and then pushed the probe on into the nasal cavity. In the case of the left duct, this was at once successful, little further treatment being required, save the daily cleaning of the duct and nasal cavity, and the injection into the canal of a two per cent. solution of ichthargan. With the opposite nostril, however, more trouble was experienced, the membranous obstruction reforming at the nasal end of the canal even after being twice removed. To insert a style that should reach quite through to the floor of the nostril, thus including the lower portion of the canal, seemed inadvisable, because of the inflammation it would occasion by pressure on the floor itself, and I, therefore, resorted to the use of a seton. With the child under ether, I passed a small, flexible probe, olive-tipped at one end, and with an eyelet armed with several threads of sterile floss silk at the other, on through the canal. With a pair of alligator nasal forceps and good illumination, it was easy to seize this probe as it appeared in the nostril, bend it sharply upon itself, and thus work it downward gradually through the canal and out through the nostril. * * * * * * * The projecting ends of the silk were brought together and tied, and the whole held safely along the side of the nose by surgeon's plaster. The seton was cleaned with boric acid solution, impregnated with a 2 per cent. solution of ichthargan, and moved every day. At the end of the week * * * * the seton was removed. The discharge soon ceased under a simple boric acid cleansing and application of ichthargan, and the child has remained well ever since."

The case illustrates: (1) The necessity of intranasal work in some of these cases of obstructive blennorrhea, and (2) the possibilities of the seton when a rebellious tendency to reclosure of the canal is experienced.

Ware, in 1793, after puncturing an abscess of the sac, introduced *a solid, uniformly small silver style* with flattened head. He claimed that it acted by dilating the passage and guiding the tears, and asserted that a complete cure, in many cases, could be obtained after its use for a month or six weeks. It caused, he declared, no inconvenience, and that any fistulous opening present at the time of operation, speedily healed.

Bickerton[18] *introduces a silver tube with a horizontal shoulder* and tapering end which rests in the divided canaliculus and prevents the tube falling from position. He first inserts a probe, but allows the tube to remain. He claims distinct superiority for his method in the treat-

[18]Bickerton. *Liverpool Med. Chir. Jour.*, Jan., 1906.

ment of all cases of chronic dacryocystitis, in which irrigation and occasional probing have failed to give relief.

Burton Cooper[19] recommends *silkworm gut*, twisted like a screw, with a silk loop at one end. The lower canal having been slit, a Galezowski dilator is introduced, the style inserted, and the loop brought out at the nostril, by the aid of mirror and speculum. The upper and lower ends are united over the cheek. On the following day the gut is cut on the cheek, and a small knob of sealing wax attached to each end. The upper, bent end of the style rests in the slit canaliculus.

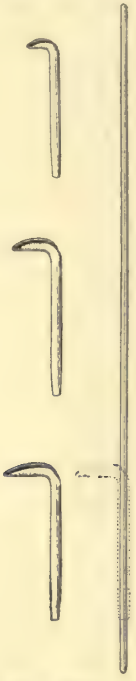


Fig. 877.
Silver Tube with Horizontal Shoulder (Bickerton).

Pond[20] uses *coarse silk thread* as a drain. The thread is passed through the duct and its free end tied. The knot is drawn through several times a day to keep the passage open.

Koster[21] draws *a loop of fine wire, or threads made stiff with gum,* through a previously inserted deWecker hollow probe. A silk suture is threaded on the wire loop, drawn up through the hollow probe, which

[19]Cooper. *Ophthalm. Review*, June, 1906.
[20]E. A. Pond. *Medical Record*, Feb., 1901.
[21]Koster. Graefe's *Arch. f. Ophthalm.*, Vol. LX, VII; see also, the ref. to Nadere Ervaring omtrent de permanente drainage van den traanafvoerweg. *Klin. Monatsbl. f. Aug.* Vol. 47, 1909, p. 630.

is then withdrawn and the two ends tied into a flat knot, which may be drawn through the duct as often as necessary. This operation does not materially differ from Pond's.

Ramsey[22] introduces a probe 26 centimeters long, one end blunt and the other with an eyelet large enough to carry Number 14 *silk thread through the nasal duct,* and draws the blunt end out of the nose by forceps. The string is drawn through the nasal duct and the ends tied together. The patient is instructed to draw the string through the nose once the first day, twice the second day, and thereafter three times daily.

Krusius[23] secures permanent drainage by the following method: A tube closely enveloping a Number 2 probe is introduced into the duct, the probe removed and the tube, slightly retracted from its original position, allowed to remain. A dry catgut is then passed through the tube, its lower end caught, drawn from the nostril, and secured. Goebel,[24] to whom the idea of the tube and sound first occurred, used a silk thread instead of the catgut.

The Use of Bougies in the Treatment of Nasal Duct Obstruction.

Stilenitz[25] and Antonelli,[26] after slitting the canaliculus and dilating the duct, introduced by Holtz's method, medicated bougies composed of cocoa butter, or gelatine in combination with protargol, or other antiseptic.

Electrolysis has been advocated by Stevenson and Jessup, Gorecki[27] Lagrange,[28] and others, in the treatment of stricture. A Bowman probe, *negative pole,* is inserted into the duct, and a platinum canula, *positive pole,* placed in the nostril, or at the back of the neck, and an electrical current not stronger than 2 ma. is turned on for thirty seconds.

Lotion[29] passes a 5 ma. current for five minutes, introducing the anode, a silver or platinum wire, into the fistula, and placing the cathode in the nares of the same side. McEnery Brown[30] does not approve Lotion's method, which is little used, and dismisses it with scant notice. He proposes, instead, that the negative electrode of a galvanic current

---

[22]Ramsey. *Trans. Otol. Sec., A. M. A.*, 1901.

[23]Krusius. Zur Dauerdrainage der Abführenden Tränenwege. *Zeitschr. f. Augenheilk.*, Vol. XXII, 3, 1909, p. 230.

[24]Goebel. *Archiv. f. Augenheilk.*, Vol. 63, No. 1.

[25]Stilenitz. *Klin. Monatsbl. f. Augenheilk.*, May, 1900.

[26]Antonelli. Traitement des affectious des voies lacrymales par les Sonders de galatine au protargol. *Annales d'Oculist.*, Oct., 1901, p. 277.

[27]Gorecki. Traitement du rétrécissement des voies lacrymales par l'electrolyse. *Recueil d'Ophtal.*, 1889, p. 557.

[28]Lagrange. *Ann. d'Ocul.*, 1900, p. 252.

[29]Lotion. *Archiv für Augenhlk.*, XL, pt. 2, 3.

[30]Brown. *Annals of Ophthalm.*, April, 1910.

be connected with the probe and passed into the duct, while a moist sponge, connected with the positive pole, is pressed on the patient's cheek.

The methods thus proposed are not commended by general observance. The truth is that electrolysis, in the present evolution of knowledge and experience, is of questionable utility in the treatment of stricture. It is, nevertheless, a future possible agency of great importance, and its precise value and applicability should be determined by further intelligent experimentation.

H. B. Harris (p. c.) describes a simple operation for *congenital atresia* of the naso-lachrymal duct, and gives the history of a successful case.

"I am well aware that the lumen of the canal in most of these cases can be established or rendered patulous, when seen early, by simply passing a Bowman's probe. The case I wish to report, however, could not be so corrected at the time it came under my care. A boy four years of age, was brought to me April 2, 1909, with the history of a bad muco-purulent discharge from the right eye since birth, for which he had been treated with drops, probing and slitting the canaliculus, for a long time following birth. * * * * * I could not pass even a No. 8 Bowman, so decided to use a small trocar, canula and obturator. The canula was the size and shape of a number 8 Bowman's probe; the obturator and trocar fitted this. After cocainizing the lachrymal canal, the canula with the obturator was passed as far down as possible. Then the obturator was withdrawn, and the trocar passed into the canula and on down to the bony obstruction. Guarded pressure was then applied to the trocar, which was made to pass through the soft bone into the inferior meatus. The canula and trocar were now withdrawn and a number 8 Bowman's probe passed, and with little pressure, found its way into the meatus, following the path made by the trocar. The case went on to rapid recovery, and has remained well ever since."

The simplicity of the operation, and of the instruments employed, the avoidance of general anesthesia and absence of any noticeable scar, are the commendable features of this operation.

Excision or Extirpation of the Lachrymal Sac.

Platner, in 1724, extirpated the sac, and made a false passage into the nose. He had few followers. An unsuccessful attempt to revive the operation was made by Rosas in 1830. In medical literature, prior to 1868, the operation is mentioned by Arlt and de Wecker, and was performed by Mooren, who did not recommend it. Berlin[31] reintroduced the operation.

Celsus, A. D. 50, referring in his *De Medicina,* to the treatment of lachrymal fistula, advocated cutting the tissues down to the bone and cauterization by hot iron or escharotics. Other and equally barbarous methods were, through ignorance of the function of the sac, in vogue until Anel, in 1712, passed a fine silver wire through the punctum and

[31]Berlin. Ueber die Exstirpation des Tränensackes, *Bericht der Ophthal. Gesell.*, 1868.

injected fluid into the sac and duct by means of his syringe. And his method, modified mechanically and in the medicaments employed, is in use at the present time. New procedures came into fashion about 1730: notably perforation of the skin, sac and bone by a single operation, and prevention of healing by insertion of hollow tubes of lead, silver or gold; simple incision, after which the *os lachrymale* was broken through by sharp-pointed and crooked forceps, the aperture enlarged and closure prevented by the introduction of a curved style. St. Yves' plan was to incise the skin one day, perforate the *os unguis* with a trocar the next, and then insert tents of lint and wood.

Pott[32] correctly determined the true origin of the disorder, which was due, he affirmed, to obstruction of the lachrymal sac or duct, and not to caries of the bone. He suggested treatment by frequent expulsion (with the finger) of the contents of the swollen sac, to prevent stagnation; the use of an astringent lotion to control suppuration; simple incision of the abscess and use of Anel's syringe; incision and dilatation of the duct; temporary introduction of a silver or whalebone probe, bougie, or catgut; the formation of an artificial passage by boring through the *os unguis* with a probe, gimlet, or curved trocar, and the daily insertion of a plated or leaden canula. Wathen, in 1781, proposed to secure a permanent communication, without breaking through the bone, by introducing a hollow metal tube or canula into the nasal duct, believing, he states, that "the restoration of the natural duct affords the only rational prospect of success."

Syringing, probing, and the employment of either hard or flexible styles, is now the classic treatment. When the disease resists these variously modified methods, extirpation of the sac, a difficult and tedious operation, is the surgeon's last resource. Various procedures, differing in minor details, have by numerous authorities been suggested from time to time, but in essentials the operation is not radically altered.

Indications for Extirpation of the Lachrymal Sac.

The probable necessity of this operation must be considered in *chronic inflammation and dilatation of the sac; inflammation of the duct; fistula, after other and less grave measures have proven ineffective; in efforts to escape danger of extension of infection in intra-ocular operations; in the protection of an eye frequently exposed to injury; in the presence of severe infection of the cornea resulting from a purulent dacryocystitis; severe ulceration of the cornea accompanied by an infected or obstructed lachrymal passage, in the patient's unwillingness or inability to remain under the surgeon's care; in physical incapacity to bear the pain of frequent probings; bilateral dacryocystitis following*

[32]Pott. *Some Observations on Fistula lachrymalis*, 1758.

the loss of one eye from hypopyon keratitis; in opening the globe in chronic blennorrhea of the sac without apparent obstruction; tuberculosis of the sac or duct; malignant growths; blennorrhea of the sac in patients suffering from trachoma (in which case infflammation of the sac, usually trachomatous, is responsible for the frequent exacerbations and recurrences of the conjunctival disease); and in mucocele with excessive ectasia.

The *prognosis* is generally favorable. Elliott[33] reports 310 operations; Dewey,[34] 29. These operators, both of extended experience, give favorable results. Toole[35] operated on eleven cases without a failure. "We know," he says, "from actual experience, that when the source of infection has been removed, irritation of the conjunctiva is allayed and that reflex irritation to tears is not produced."

The conditions most frequently contributing to *failure* in this operation, are extensive involvement of the bones, muco-purulent infiltration of the soft tissues, and to the operator's inexperience, lack of skill, or lamentable ignorance of the anatomy and pathology of the structures invaded. Following the operation, the secretion of tears gradually diminishes and is hardly noticeable after the lapse of six or eight weeks. This fact is due, probably, not yet demonstrably, to the impression made upon the innervating nerves. Should epiphora continue as a complicating annoyance, the accessory lachrymal gland should be removed.

The occasional recurrent statement that *atrophy of the gland* follows extirpation of the sac, is without proof. Axenfeld[36] and Bietti have shown that there are microscopic indications of atrophic changes, fat tissues and granules, in the normal gland. They examined sections of glands in numerous cases where the sac had been previously excised, but found no further evidence of degenerative changes.

The Technique of Excision of the Lachrymal Sac.

Among the necessary prerequisites to the correct performance of this operation, must be included the surgeon's working familiarity with the anatomy of the parts involved.

The sac lies in the groove of the lachrymal bone, and is protected on the nasal side by the nasal process of the superior maxillary bone. The *anterior lachrymal crest,* a prominence on the nasal process, is in front of and partly overlies, the lower third of the sac. The *posterior lachrymal crest,* the delicate thin edge of the lachrymal bone, is situated behind and above the upper portion of the sac. The tendo-oculi,

[33] Elliott. *Ophthalm. Record,* Feb., 1908.
[34] Dewey. *Ophthal, Record,* Feb., 1908.
[35] Toole. *Brit. Med. Jour.,* 1906.
[36] Axenfeld. Ueber die feinere Histologie der Thränendrüse, besonders über das Vorkommen von "Fett" in den Epithelien. *Bericht der Ophthalm. Gessell.,* 1900, p. 160.

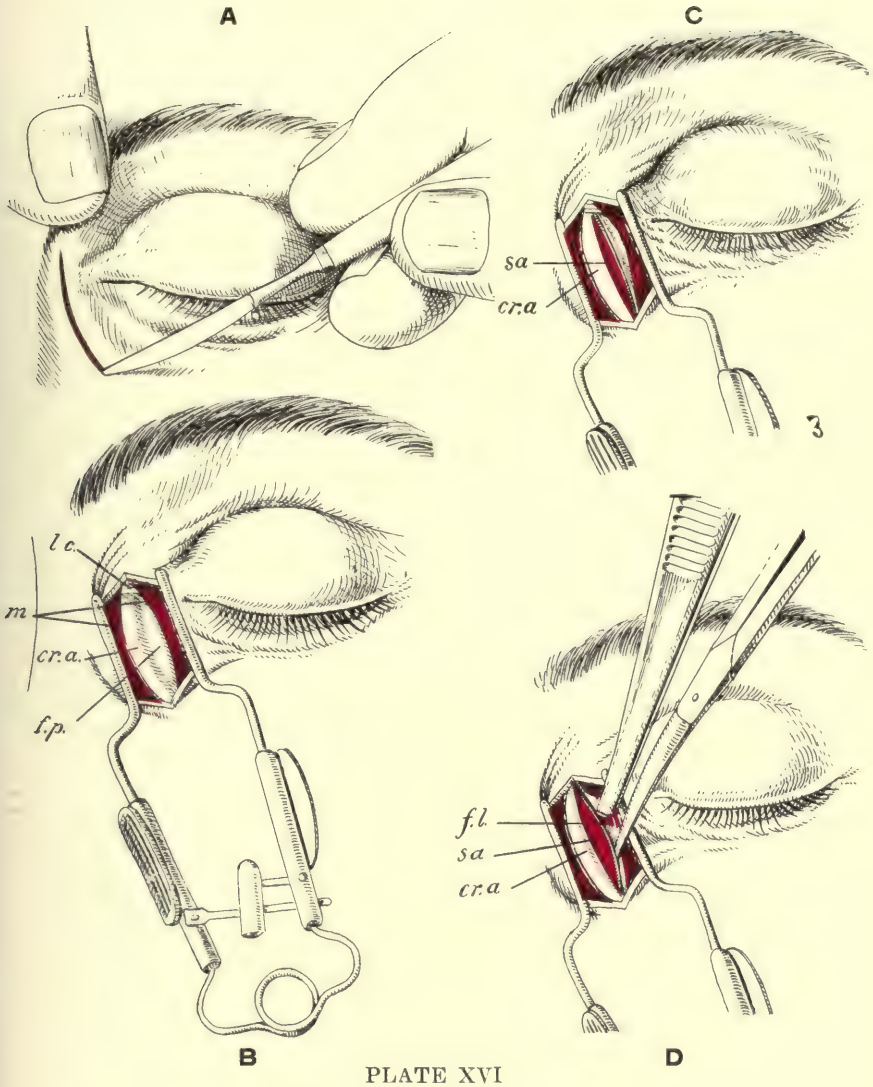


PLATE XVI

Excision of the Lachrymal Sac.

A. The skin towards the inner canthus is fixed by the thumb of the left hand so that it cannot be pulled or stretched when the slightly curved incision is made from above downwards. The cut is placed about 3½ mm. from the inner canthus. (After Meller).

B. The sac is to be found in the deep wound (f.p.) on separating the fibres of the muscle (m.). The internal canthal ligament (l.c.)is seen in the upper angle of the wound. The anterior lachrymal crest (cr.a.) can then be felt and sometimes seen. (After Meller).

C. The incision is now made through the deep fascia and the whole length of the wound about 1 mm. behind and to the side of the anterior lachrymal crest (cr.a). The lachrymal sac (sa.), of a reddish-blue color, should now be seen. The incision also cuts through the internal canthal ligament. (After Meller).

D. The margin of the wound in the fascia (f.l.) is grasped by forceps. With the closed arms of the scissors the loose connective tissue the sac (sa.) and the deep fascia are separated. (After Meller).

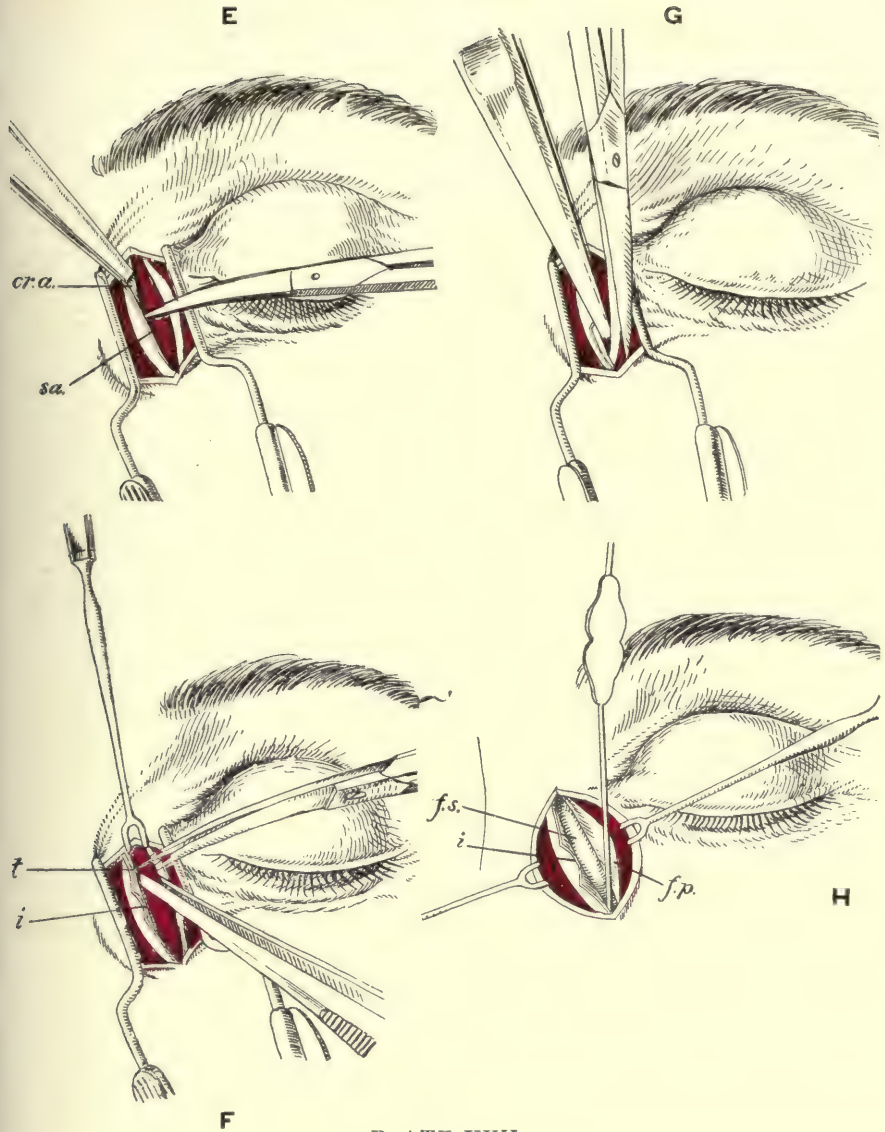


PLATE XVII

Excision of the Lachrymal Sac.

E. An incision is now made in the margin of the fascial wound about its center, exposing the anterior lachrymal crest (cr.a.) After this cut the closed scissors are readily passed between the bone and the sac (sa.), so as to loosen the latter. The scissors point is always directed towards the bone beneath. (After Meller).

F. The sac (f,) having been freely separated from the surrounding structures is seized by the forceps near its apex and is further lifted from its bed by short cuts of the scissors, keeping as close to the sac wall as possible. The superior margin of the wound is drawn upwards with a pointed hook. (After Meller).

G. The sac is now seized with the forceps at its inferior end, after it has been separated from the surrounding tissues. By means of the scissors all the neighboring parts are cut away as far as the lachrymal duct. (After Meller).

H. The field of operation after completion of the excision. The lachrymal fossa (f.s.) is empty, its external border being formed by the deep fascia (f.p.). At this point it is attached to the posterior lachrymal crest. A probe is passed through the duct to the nose. The skin edges of the wound are held apart by double tenacula. (After Meller).

internal canthal ligament, arises from the upper extremity of the nasal process and is divided into two portions, attached separately to each tarsus. The attachments cover the upper portion of the sac. Back of the sac, attached to the post-lachrymal crest, is the muscle of Horner. Posterior to this muscle, which separates the tissues mentioned from the orbit, is the orbital fascia. The arteries and veins, numerous and important in this situation, are well shown in Plate XIV.

The Incision.—With a sharp, straight, convex-edge bistoury, incision through the skin is begun at a point 2 millimeters above the ligament of the internal canthus and 3 or 4 millimeters to the nasal side of the inner extremity of the canthus and carried straight downwards for a distance of about 1½ centimeters. Kuhnt's[37] incision extends downward and outward for 20 to 25 millimeters along the margin of the orbit. Axenfeld[38] incises 3 millimeters in front of the lachrymal crest. Landolt[39] prefers to begin the incision 7.5 millimeters above and 15 millimeters from the inner angle, with a 2 millimeters curve toward the eye.

The preliminary incision must be large. It should begin about 1 centimeter above the tendo-oculi and pass downward along the crest of the ascending process of the superior maxillary, curving outward to the junction of the inner and middle third of the inferior border of the orbit. The length of the cut through the skin will be about 4 centimeters. By careful dissection, the surgeon lays bare the anterior lachrymal crest, separating the wall of the sac from the underlying bone. This may be done with a scalpel. The edges of the wound are separated as widely as possible and held by Müller's (or a similar) speculum. All superficial fascia, the palpebral portion of the orbicularis muscle, and the dense white subjacent or deep fascia, are carefully dissected away until, step by step, the sac is exposed. Its upper portion is still concealed by the ligament.

During the dissection, the operator should be guided by the position of the anterior lachrymal crest, and "by not dissecting too near to the median line, he will, on the one hand, escape the mistake of incising the periosteum of the dorsum of the nose, instead of freeing the lachrymal sac, and, on the other hand, keep from going in the wrong direction from the sac toward the orbit." (Meller). The delicate, posterior lachrymal crest does not come into view, it should be remembered, until the deep fascia has been removed. The surgeon, with closed scissors, now carefully separates the nuclear side of the sac from the deep fascia, and

[37] Kuhnt. *Zur Exstirpation des Tränensackes, Zeitschr. f. Augenheilk.*, 1902, p. 441.

[38] Axenfeld. Bermerkungen und Instrumente zur Tränensackextirpation. *Bericht der Ophthal. Gesell*, 1905, p. 232.

[39] Landolt. *Ophthal. Klinik.*, Jan. 20, 1907.

divides the openings of the canaliculi close to its connections. By means of a strabismus hook, the entire length of the sac is easily detached from its groove. Its upper extremity is still firmly held down by the ligament and the surgeon, at this step in the dissection, must be on his guard and keep close to the sac, avoiding the large blood vessels, numerous in this situation. The sac is lifted from its bed, firmly held by forceps, and its prolongations into the nasal duct divided by scissors. The duct is probed, cicatricial formations divided and curetted, and diseased portions of bone or membrane removed. The cutaneous wound is then closed by two or three fine silk sutures. Great care should be exercised in bringing the edges of the wound into close apposition. If the sac has been thoroughly removed, and proper precautions against infection observed, the wound usually heals by first intention. No drainage, aside from that afforded by the nasal duct itself, need be provided.

The toilet of the wound is simple. A small pad of antiseptic gauze is placed over the closed lids and a roll of the same material pressed firmly against the wound, to insure obliteration of the groove from which the sac has been removed. This swathing is held in place by additional layers of gauze secured by a roller bandage. The patient is confined to bed, and told not to disturb the dressing. The day after the operation, should there be no complaint of pain, or evidence of hemorrhage, the bandage need not be disturbed. Landolt[40] packs the wound with iodoform gauze, which is withdrawn on the second or third day, and removes the sutures on the seventh or eighth day.

If the patient complains of discomfort in the region of the wound, the dressing should be removed and the parts inspected. Gently applied pressure on the lachrymal bone may expel through the canaliculi, more frequently the lower, a small quantity of bloody serum, not previously drained through the duct. After expression of this accumulation, the feeling of tension usually subsides. This procedure should be repeated as often as the wound is dressed. On the third day the bandage and pads should be removed without disturbance of the gauze over the sac, and on the following day, the entire dressing, including the sutures, may be removed.

J. J. Thompson describes a method for the removal of the lachrymal sac which, he claims, renders the operation extremely simple.

"Cutting down on the sac and removing it in its entirety to me, seems very difficult, because there are no definite landmarks to guide one. When paraffin is resorted to, that agent frequently passes into the nose, especially in cases where Bowman's operation has been done, and large probes have been passed; or, on the other hand, if a stricture exists, it backs up through the canaliculus around the point of the syringe. What seems a more simple method is this: When the canaliculus has not already been cut, do so,

[40] Landolt. *Die Oph. Klin.*, Jan. 20, 1907.

and then introduce a small Theobald probe and leave it in place. This gives a good idea of the position of the sac, and the bony foramen that it fills. The usual curved incision is then made, beginning about 1 centimeter above the tendo-oculi, and extending downwards and outwards about 2½ centimeters below it.

"This incision, below the tendo-oculi, should reach as deep as the sac wall, and the overlying structures should then be dissected from it for a short distance on each side. As soon as the nasal process of the superior maxilla is exposed, the point of the hook which I have had made for the purpose should be passed into the foramen beside the nasal duct. If it is then turned at right angles and forced to follow the margin of the foramen outwards and behind the Theobald probe, it will come out just to the outer side of the sac, and by drawing upward on it one can be assured that it is really behind the probe and the sac. A heavy piece of silk is then threaded into the eye which is made in the hook for that purpose, and drawn around behind the sac. This ligature is tied as far down as possible, while at the same time the probe is withdrawn. We are thus enabled to tie the sac off at its lowest part, and if it contains pus, infection of the wound may be avoided. By rubbing the hook up and down a few times before withdrawing it, the sac is readily freed from its posterior attachment. Now, while drawing up on the ligature, the junction of the sac and nasal duct is cut across well within the bony canal, and by keeping the ligature tight, with a few strokes of the knife the sac is separated from the surrounding structures, as high as the tendo oculi.

"Traction downwards is then made on the ligature, and with the point of the knife the dome of the sac is dissected from beneath the internal palpebral ligament, leaving it intact. The nasal duct is now curetted, and a pledget of cotton soaked in 95 per cent. alcohol is pressed into the cavity to stop bleeding and act as an antiseptic. The wound is then sutured and aristol blown over it, after which the canaliculus is cauterized with the galvanic cautery or platinum tip. A small roll of gauze is placed over the wound, and held in position by a pressure bandage to force the skin against the underlying structures, and primary union may be expected.

"During the past year this technic has been followed in fifteen cases at the Manhattan Eye, Ear and Throat Hospital, with gratifying results. the entire sac being removed intact without difficulty. Axenfeld's retractor has not been used, the hemorrhage being controlled by hemostats, and I think by shortening the incision, considerable of the hemorrhage, which is at times profuse, may be avoided."

Cirincione, after making the usual incision, as described above, with a specially devised knife, divides the aponeurosis which fixes the sac to the bony orifice and separates the mucous canal from the periosteum. This part of the dissection is almost impossible without a knife so devised that its shaft is twice bent at right angles, a mechanism which brings the blade in parallelism to, and only a little distance from the plane of the handle. Both edges are sharp with rounded points. When the whole canal is finally freed from its attachments, the mucous membrane is divided at its junction with the inferior meatus of the nose, and both sac and duct drawn away together. Sometimes it is not possible to detach, in this way, all parts of the canal. If the bony duct be small, the surgeon may succeed in removing only the upper part of the mucous membrane. In this case, the remaining part should be destroyed by the introduction of a galvanic cautery. Should it be necessary, the canaliculi are closed by the cautery, the surface wound sewn up, and a pressure bandage applied.

Extirpation of the Lachrymal Sac with Insertion of a Silver Prothesis.

Zimmerman[41] extirpates the sac by an incision 3 to 5 millimeters in length, carried vertically through the skin to the crista, using for the purpose, the periosteal rasp designed by Leschaft. The periosteum is elevated the entire length of the wound and down to the fossa lachrymalis, which may be recognized by its resistance to the instrument. Separation of the posterior wall of the sac displays the entire field of operation. An assistant draws the sac, together with the surrounding tissue, down towards the nose. The operator grasps the outer tegument by forceps, and with dull scissors dissects it loose from the sac. The sac is then severed from the skin. After cessation of bleeding, the silver prothesis is inserted. It rests well in the fossa lachrymalis. A large tampon, which rests lightly on the wound, is the only dressing required. The stitches, ordinarily, are removed on the fifth day.

Obliteration of the Lachrymal Sac.

Scheffels[42] slits up both canaliculi and divides all strictures at the sac entrance. He then cauterizes the cavity with Vienna paste moulded in the form of a small ball and wrapped in a thin layer of cotton, which he places at the bottom of the sac. He removes this mould in two minutes, cleanses the sac, packs it with cotton, and protects the eye with vaseline dressing.

Randolph and West, at the 1910 meeting of the American Ophthalmological Society, described an operation for the relief of dacryocystitis which is of distinct promise, more especially, it seems, *in cases* of *obstructed nasal duct due to injury*. The essential feature of their operation, is the establishment of a large opening, or window, into the nose at the lower end of the nasal duct, extending the caliber of the duct laterally to its apex. In the two reported cases of injury, in which the nose was smashed in, the results were brilliant and apparently permanent. The authors, however, point out that inasmuch as only a few recent cases have been operated on the time (twelve months) is too brief to enable them to draw definite conclusions from their experience.

Accidents During Excision of the Sac.

To avoid possible *erosion of the cornea,* the commissure should be closed during the operation, as exposure subjects its surface to injury and infection. Either of these conditions is a serious complication, likely to eventuate, if not promptly checked, in necrosis of the cornea and loss of the eye. For this reason, *cocain and adrenalin* should not be em-

[41]Zimmerman. *Die Oph. Klinik.*, Sept., 1907.

[42]Scheffels. Ueber Thränensackverödung und ihre Bedeutung für den Praktiker, verglichen mit der Thränensackextirpation. *Klin. Monatsbl. f. Augenhlk.*, April, 1901, p. 275.

ployed. The rule applies with lessened force to the employment of a general anesthetic, although ether or chloroform inadvertently dropped into the conjunctival or lachrymal sac, already aggravated by altered secretions, may light up a purulent conjunctivitis, or a sloughing ulceration of the cornea. Erosion of the cornea may also be produced by the curved points of the speculum in its bungling adjustment within the wound, or by the careless handling of other instruments.

Hemorrhage During Excision of the Lachrymal Sac.

The position and relation of the blood vessels in the area of operation as exhibited in the accompanying illustration, clearly define the necessity of making the incision with due regard to the anatomical relations of the route pursued through the tissues; that is to say, not too close to the nasal side of the orbital border, in which situation lie the nasal and angular arteries and veins. Profuse bleeding is also the likely result of careless dissection around the upper border of the sac. In the event of hemorrhage, and it is sometimes unavoidable, the smaller vessels should be compressed against the nasal bone, and bleeding from the larger ones controlled by torsion. Capillary outpouring into the field of operation is readily checked by adrenalin and hot water douches.

Retention of a part of the posterior wall of the sac exceptionally occurs in necrosis of the lachrymal bone, and in partial destruction or friability of the sac. It more frequently follows separation of the upper portion of the sac, which is closely adherent to its fibrous attachments, from which it must be carefully detached with sharp-pointed scissors. The lachrymal bone, after removal of the sac, must be closely inspected, and the remnants either caught by forceps and cut away, or the entire surface curetted.

Retention of the smallest part of the mucous membrane is likely to result in failure of the operation, due to muco-purulent discharges into the wound, hypertrophy of its epithelium, or to its investment by granulations, which establish a connecting link between the conjunctival sac above and the nasal duct below, distending the wound and forming a fistulous opening.

Should purulency of the wound be suspected, the sutures must be removed and the retained secretions allowed free exit. The wound should then be thoroughly cleansed with a weak bichloride solution, and loosely packed with iodoform gauze. Curettement at this time, Meller declares, is of no appreciable service, as "it is impossible, during the period of granulation, to recognize all the details of the wound." Should a fistula form, it must be completely excised, and the fossa thoroughly cleansed and allowed to heal by granulation.

Pfalz[43] suggests that "on both sides of the freshened fistula, two

vertical incisions, 5 millimeters apart, be made, and a double-needled suture entered in one wound and brought out from the other in such a manner that one thread passes above and the other below the fistula. By tying the ends, these subcutaneous sutures surround the fistula."

Incision into the orbital fossa during excision of the lachrymal sac. This accident is at once recognized by the protrusion of orbital fat into the field of operation. It is usually accompanied by profuse hemorrhage. Ordinarily, its only disadvantage to the operator is the delay imposed by excision of the fat and control of the hemorrhage. The chief ultimate danger lies in the possible infection of the orbital connective tissue, purulent orbital cellulitis, destruction of vision and, rarely, purulent meningitis.

General anesthesia as a prelude to excision of the sac is advisable only in patients of extremely nervous temperament, necrosis of the bone, or when an extensive operation is in contemplation. *Local anesthesia* and anemia of the tissues, induced by injections of cocain and adrenalin, suffice in most instances. For this purpose, Meller employs with satisfaction a Pravaz syringe of 1 cc. capacity, containing eight parts of 1 per cent. solution of cocain, and two parts of adrenalin solution (1-1,000). Landolt's solution is practically the same; nine parts of a 1 per cent. solution of cocain, to one part of adrenalin, 1-1,000. Meller first injects one-third of its contents below the tarsal ligament, the second third above the ligament, and discharges the remaining third close to the orifice of the nasal duct. Czermak advises only one insertion of the needle, 1½ centimeters below and outward from the inner angle of the lid. First a few drops are injected, the needle is then slowly pushed outward and upward under the skin to about 1 centimeter above the tarsal ligament and several more drops injected. He then partly withdraws the needle, and so changes its direction that the remaining portion of the solution may be injected under the ligament and fascia to the lateral side of the sac, thus anesthetizing its median wall. The conjunctival and lachrymal sacs and canaliculi should, he contends, be anesthetized by injection of cocain, using the ordinary lachrymal syringe for the purpose.

Extirpation of the Lachrymal Gland.

The first extirpation of the lachrymal gland for the cure of excessive lachrymation, was reported by Paul Bernard[44] in 1843. Szokalski had discovered by experiments on animals that destruction of the gland was not followed by disease of the eye, an opinion not previously held,

[43]Pfalz. Ueber Operationenverschluss Veralteter Thraenenfisteln. Ref. *Michel's Jahresber. für Ophthal.*, 1901.

[44]Bernard. *Mémoire* presented to the *Academie des Sciences de Paris*, Oct. 16, 1843.

and that the conjunctiva, caruncle and Meibomian glands afforded sufficient secretion to lubricate the ball. He advocated removal of the superior gland by an incision through the integument directly over it, and should this procedure prove insufficient to control the symptoms, the palpebral portion of the gland is also to be removed.

The same operation was afterward practised by Textor in Germany, by Lawrence in England, and by de Wecker and Abadie in France. The risk from ptosis, suppuration, hemorrhage into the orbit, compression of the optic nerve, and from thrombosis, induced de Wecker to substitute extirpation through the conjunctiva; a procedure now in universal practice.

Excision of the Inferior Lachrymal Gland.

The inferior lobe of the lachrymal gland lies immediately above the conjunctiva at the outer and upper fornix, and is enclosed in a connective tissue capsule. By everting the lid and forcing the upper fornix downward by means of a blunt hook, or similar instrument, the gland with its covering of mucous membrane is brought into view. Thus exposed, it is held by a pair of blunt forceps for removal. The posterior arm of the forceps should be one centimeter larger than its anterior arm. A horizontal incision through the conjunctiva with scissors 1 centimeter in length, is made on the projecting gland. The underlying connective tissue, which forms an imperfect capsule, is dissected and the exposed gland grasped by forceps, lifted from its bed, and cut from its orbital attachments. The tubules, extending from the upper to the lower section of the gland are thus divided, and the transit of tears into the conjunctival sac prevented. The operation, under applications of cocain to the conjunctiva, and injection of a mixed solution of cocain and adrenalin into the connective tissue surrounding the gland, is painless. The edges of the conjunctival wound are united by a single suture of catgut or silk. Ecchymosis of the conjunctiva and swelling of the lids generally follow the operation, but soon disappear.

Excision of the Superior Lachrymal or Orbital Gland.

It is advisable, in this operation, to shave the eyebrow as an additional precautionary measure. Under general anesthesia, a curved incision, its concavity downward and in conformity with the curve of the orbital margin, is made through the skin and intervening tissues to the periosteum of the outer half of the lower edge of the orbital border. The parts are separated, and the wound held open by a Müller or Eversbusch speculum. The orbital fascia is divided close to the bone, the surgeon exercising proper care to avoid wounding the broad fascia of the levator muscle. The gland thus exposed to view is grasped by broad forceps and cut close to the periosteum.

Hemorrhage from division of the lachrymal artery is likely to be profuse, but is readily checked by ligature. The divided fascia and skin should be separately united by catgut sutures. Healing is usually prompt but in exceptional cases the tissues become infected and orbital phelgmon results. If there be the slightest suspicion of infection, the cavity should for a few days be drained by iodoform gauze.

Sauvineau[45] has described a case of recovery from infectious keratitis, which resisted all curative efforts until he discovered an associated purulent inflammation of the lachrymal gland, and directed his treatment to the relief of that affection. This case, he asserts, is the first published in which purulent disease of the gland is mentioned as the cause of infection of the cornea, although phlyctenular and purulent keratitis are well-known consequences of disease of the lachrymal sac and duct.

Surgical Treatment of Dacryops.

Cystoid dilatation of a duct of the lachrymal gland is of rare occurrence. Rogman[46] collected records of twenty-four, and Zur-Nedden[47] thirty-three cases. The condition, in the majority of instances, is attributable to pre-existing inflammation, but may be congenital. Removal of the entire cyst is indicated. If the case be complicated by the presence of a fistula which discharges through the outer integument, to the distress of the patient, the surest relief is afforded by excision of the gland. The cyst is exposed, its adhesions to the cartilage severed, the contributing duct tied, and the gland separated from surrounding tissue in the fornix by blunt dissection. A single conjunctival suture is required.

Tumors of the lachrymal gland, persistent overflow of tears not controlled by other and less severe methods of treatment, paralysis of the orbicularis and eversion of the puncta, severe and persistent trachoma, and other forms of inflammation of the conjunctiva, are strongly indicative that partial or complete extirpation of the gland may, in the end, be the patient's only dependency. These operations, nevertheless, are radical measures, and should be held in reserve until the surgeon's matured judgment is under conviction of the belief that operative interference offers the only sure means of relief from prolonged suffering.

Separately to classify and paragraph the various forms of *trau-*

---

[45]Sauvineau. Kératite à répétition par dacryoadénite infectieuse. *Bull. et Mém. de la Soc. Française d'Ophtal.*, 1896, p. 355.

[46]Rogman. Traitement Opératoire de la Myopie. *Annales d'Oculist.*, Jan., 1899, p. 1.

[47]Zur Nedden. *Klin. Monatsbl. f. Augenhlk.*, April, 1902.

matism (penetrating punctures, cuts, shot wounds, burns, etc.) and *tumors* (endotheliomata, sarcomata, lymphomata, papillomata, osteomata, syphilomata, angiomata, polyp, dermoid cysts, etc.) seems to us unnecessary, as they occur under exceptional conditions and must be treated in accordance with the general principles of surgery applicable to the given case.

With the exceptions already noted, the *lachrymal gland* is rarely the original seat of a pathological process, but the *sac and ducts,* on the contrary, are the frequent sources of trouble, in many instances so concealed that the surgeon is likely to be misled into inaccuracies of diagnosis and treatment. Liability to the commission of errors of this nature, is minimized by giving invariably close attention to the individual case (its history, symptomatology, pathology, etc.) If it be a tumor which the surgeon has under observation, he should, moreover, endeavor to find out its exact character, i. e., location, size, attachments, solidity and rapidity of growth. An intelligent conception of the importance of these diagnostic factors should determine the question of operative interference.

When the surgeon is reasonably sure of his diagnosis, that is to say, when the etiology and pathology of the affection are not indeterminable problems, and the case demands surgical interposition, operation should not be needlessly delayed, for the question of time is often of vital importance, especially in dealing with inflammations and rapidly growing tumors of the lachrymal apparatus.

CHAPTER II.

OPERATIONS ON THE NOSE AND ITS ACCESSORY SINUSES FOR THE RELIEF OF OCULAR SYMPTOMS.

By FRANK BRAWLEY, M. D., Chicago.

The Surgical Relations of the Nose and Its Accessory Sinuses to the Orbit and Ocular Structures—Diseases of the Eyelids and Conjunctiva Due to Nasal Disease—Affections of the Lacrimal Apparatus from Diseases of the Neighboring Cavities—Alterations in the Cornea and Sclera, Due to Nasal and Sinus Diseases—Oculo-Muscular Disturbances and Accessory Sinus Diseases—Intraocular Disease Due to Nasal and Sinus Affections—Diseases of the Orbit Due to Affections of the Nose and Neighboring Cavities—Surgical Anatomy of the Frontal Sinus—Operative and Other Treatment of Frontal Sinus Diseases Producing Eye Symptoms—After-Treatment of Frontal Sinus Operations—Ingals' Operation for Opening the Frontal Sinus—Halle's Operation—External Frontal Sinus Operations—Operation of Hajek-Luc—Operation of Nebinger-Praun—Operation of Kuhnt—Operation of Jansen—Operation of Killian—Osteoplastic Operations on the Frontal Sinus for the Relief of Eye Symptoms—The Maxillary Sinus and Its Surgical Anatomy—Diagnosis—Treatment of Diseases of the Antrum of Highmore—Operations on the Antral Walls—Radical Operations on the Maxillary Sinus—The Denker Operation—The Sturmann Operation—The Robertson Operation on the Maxillary Sinus—Intranasal Operations on the Naso-lachrymal Duct—After-Treatment of Antrum Operations—Surgical Anatomy of the Ethmoid Labyrinth—Diagnosis of Ethmoid Diseases—Surgical Treatment of Ethmoidal Disease—Ballenger's Operation for Removal of the Ethmoid Cells—External Operations Upon the Ethmoidal Cells—Surgical Anatomy of the Sphenoidal Sinus—Diagnosis of Sphenoidal Disease—Ocular Symptoms of Sphenoid Disease—Operative Treatment of Sphenoidal Affections—Hajek's Operation on the Sphenoid Sinus—The Relations of Diseases of the Cavernous Sinus to Ocular Symptoms—Operations on the Cavernous Sinus.

THE SURGICAL RELATIONS OF THE NOSE AND ITS ACCESSORY SINUSES TO THE ORBIT AND OCULAR STRUCTURES.

To-day an intimate knowledge of the close relations existing between the nose, its accessory cavities and the ocular apparatus is in-

dispensable to the ophthalmologist. He may or may not feel competent to undertake the task of making a nasal diagnosis, in which latter case he may avail himself of the services of a skilled rhinologist. In either event such intelligent co-operation is certain to be of great benefit to both and will rapidly add to our knowledge of these allied subjects.

It is not unlikely that the increased interest in these naso-ocular relations manifested during the past five years will result in a class of specialists who will confine themselves to ophthalmology and rhinology. The most important reason why the eye specialist should be familiar with the nasal cavities, at least from a diagnostic standpoint, is because many of the earliest symptoms of disease of the accessory sinuses are ocular and patients suffering from such symptoms present themselves to the oculist for treatment.

Eversbusch[1] has made a very exhaustive research of the literature dealing with the intimate relations between nose and eye in which he gives credit to the pioneers in this field, Berger-Tyrmann, Germann, Hajek, Kuhnt, Vossius, Winckler and Ziem. A very good clinical classification of those diseases of the nasal sinuses which affect the eye is that given by Mackay.[2] There are four groups: first, mucoceles of the sinuses; second, acute or chronic sinuitis with external signs of orbital cellulitis, orbital abscess, tumor growth, edema of the eyelids or apparent dacryocystitis; third, sinuitis without external signs of orbital inflammation, but with ophthalmoscopic signs such as optic neuritis, neuro-retinitis, retinal thrombosis or phlebitis, or without ophthalmoscopic signs but with visual disturbances such as central scotoma, visual field defects, ocular muscle paralyses or fifth nerve disturbances; fourth, cases in which the association of sinus disease has been asserted but which Mackay considers questionable, such as glaucoma, iritis, uveitis, keratitis and lens and vitreous opacities.

Another class of cases which is very important to the ophthalmologist has been omitted, namely the *unilateral headaches and asthenopic symptoms* due to rarefaction of the air within the frontal sinus and anterior ethmoidal cells. The pain is unilateral, although if severe it may become general later in the attack. Stooping increases the pain and slight vertigo frequently is noted upon assuming the erect position. Lachrymation, edema of the upper eyelid and injection of the conjunctival vessels have frequently been noted in this condition. During the attack the patient is unable to read without aggravating the

---

[1]Eversbusch. Die Erkrankungen des Auges in ihren Beziehungen zu Erkrankungen der Nase und deren Nebenhöhlen, sowie zu Erkrankungen des Gehörorganes. *Graefe-Saemisch Handbuch der Gesamten Augenheilk.*, 1903.

[2]George Mackay. Discussion: The Relation of Disease of the Nasal Accessory Sinuses to Disease of the Eye. *The Lancet*, p. 397, Aug., 1908.

symptoms, and complains of blurred vision, although during the intervals between the attacks the eyes may be used for near work with perfect comfort. The attacks seem to be brought on by an acute coryza, the menstrual period or damp, chilly weather. There is usually tenderness to pressure against the floor of the frontal sinus, especially in the region of the pulley of the superior oblique muscle and against the inner wall of the orbit, the os planum of the ethmoid. This symptom is not constant, but may often be elicited by producing pressure on corresponding points in both orbits simultaneously, when greater tenderness will be felt on the affected side. The nasal examination may be negative even when made by a competent rhinologist, but if the patient is seen during the attack the middle turbinal will usually appear turgescent or will be found closely applied to the lateral nasal wall, blocking the hiatus semilunaris. The attack may then be modified or entirely relieved by the application of cocain and suprarenalin to the middle turbinal and infundibulum. When such a case is observed between attacks it is often possible to produce the symptoms by applying the author's suction pump, subsequently relieving the congestion thus produced by the use of cocain and suprarenalin as previously described. Then, having proved the diagnosis the relief may be made permanent by resecting sufficient of the middle turbinal to uncover the lower end of the fronto-nasal duct and hiatus.

Ziegler[3] gives as the *three chief nasal sources of reflex ocular symptoms,* pressure contact, hyperesthesia and nasal obstruction. In the first case the middle turbinal may produce pressure against the septum, which at this point is most sensitive, and may even produce a turgescent hyperesthetic area on the septum. This contact may cause muscular twitchings or choreiform movements of the face, head and neck and also severe headache. A sharp septal spur may produce the same effect by pressing into one or the other turbinate body. Synechiae act similarly. Ziegler calls the septal area opposite the anterior third of the middle turbinate body the "eye spot of the nose" as it is a frequent source of the ocular reflex symptoms, such as supraorbital neuralgia, lachrymation, congestion of the conjunctiva with burning and smarting of the lids, blepharitis, etc. Irritation at this spot will produce frequently the same symptoms which the patient experiences during his attacks. Where middle turbinals impede respiration and prevent air from reaching the superior meatus in the so-called attic of the nose, these various reflex eye symptoms may be called forth. The "Sunday morning headache" in his opinion is due to prolonged pressure-contact between the middle turbinals and the septum from sleeping unusually late.

---

[3]Ziegler. *N. Y. Med. Jour.*, Nov. 7, 1908.

In a series of cases published by Hoople[4] asthenopic symptoms and muscular imbalance were present and were found to be due to pressure of the middle turbinal against the septum as shown by a return to normal following removal of that portion of the turbinal producing the pressure.

The *headache of nasal disease* very closely resembles that due to refractive and muscular anomalies of the eyes, and consequently the oculist sees these cases frequently in the earliest stages. Snydacker's[5] statistics show that in seven to ten per cent. of the patients who consult an opthalmologist on account of headaches, the cause is to be found in disease of the accessory sinuses of the nose.

The *location* of the headaches is not characteristic of disease of a particular sinus, although in general the pain of a frontal sinuitis for instance, is located over the area occupied by that sinus. Sinus headache may occur during the night, an unusual time for the occurrence of ocular headache, except when due to a definite inflammation such as an iritis. It is possible for confusion to arise in seeking the source of headache and asthenopic symptoms, especially muscular asthenopia, where the degree of the refractive error and the muscular anomalies are sufficient in themselves to account for all symptoms.

Sinus headache is frequently paroxysmal in character, occurring at a regular hour, usually in the morning and ending at a corresponding time each day. Frontal sinus headache is usually noted in the frontal region, although reflex pain may occur in the occipital region, frequently occupying a circumscribed area.

Ethmoidal pain is most frequently felt at the root of the nose or behind the eye and may be exaggerated by ocular excursions.

The *pain of antrum disease* is often referred to the teeth of the corresponding upper jaw or backward to the ear or side of the head and is markedly increased by stooping. This symptom of increase in the headache accompanied by a sensation of pressure upon stooping is very characteristic of the more acute forms of sinus disease.

Sphenoidal disease is productive of occipital and temporal headache or pain at the "base of the brain" and back of the eyes. Cases of chronic sinus disease are frequently entirely free from pain, although upon palpation, tenderness of the sinus walls may be elicited.

Disturbance of the Visual Fields.

The most frequent change found in the field of vision is a unilateral central scotoma for colors and in a more advanced stage for

---

[4]Hoople. *Medical News*, April 13, 1901.

[5]Snydacker. Zur Differentialdiagnose zwischen okularen Kopfschmerzen und solchen verursacht von Nebenhöhlenentzündungen. *Klinische Monatsblätter f. Augenheilk.*, June, 1909, p. 628.

white as well. In some instances a distinct retrobulbar neuritis occurs with blurred central vision gradually extending to the rest of the field and producing partial or complete blindness. In the early stages no fundus changes are to be seen, but, later, the margins of the disc become hazy or papilledema or a distinct optic neuritis may be found.

In five per cent of eighty-three cases reported by Birch-Hirschfeld[6] of orbital involvement secondary to ethmoidal disease changes were found in the visual fields. He also refers to eight cases, one of which occurred in his own practice, where the finding of an absolute central scotoma aided in the diagnosis of a sphenoidal sinus infection. Three cases of sphenoidal disease with a small central scotoma for red, some orbital pain and supraorbital neuralgia were observed by Birch-Hirschfeld, which were relieved by drainage of the sphenoidal sinus.

It is not always possible to make a differential diagnosis in these cases, but in general they are unilateral as against the bilateral scotomata of general toxemias, such as alcohol-tobacco amblyopia and are also of much more sudden inception, more rapid in their course and are accompanied by pain.

Diseases of the Eyelids and Conjunctiva Due to Nasal Disease.

Edema, usually involving the upper lid, occurs as the result of disease of the frontal sinus and anterior ethmoidal cells particularly, and is due to venous stasis. This form of edema is usually greater in the morning and lessens as drainage from the sinus takes place. It is to be distinguished from the tense infiltration of the lids, with dusky red discoloration of the skin, which is seen in orbital cellulitis or abscess and which is usually accompanied by edema of the bulbar conjunctiva, proptosis and hyperpyrexia.

The so-called "fugitive edema" of the eyelids which has long been recognized as accompanying periodic headaches is probably due in many instances to unsuspected sinus disease. This opinion is held by de Schweinitz[7] who quotes a case reported by Dunn[8] where a recurrent edema of the upper eyelid was relieved by removal of a myxomatous middle turbinal with polypi. No reference was made by Dunn to a possible sinus condition, but de Schweinitz believes that the operative measures probably served to provide drainage for unsuspected disease of one or more sinuses. Edema of the upper eyelid

---

[6]Birch-Hirschfeld. Die Beziehungen der entzüundlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monatsbl. für Augenheil.*, Jan., 1908, p. 1.

[7]de Schweinitz. Some Observations of the Ocular Manifestations of Sinus Disease. *Trans. Amer. Ophthal. Soc.*, 1910, p. 480.

[8]Dunn. A Case of Recurrent Oedema of the Upper Eyelid as a Symptom of Nasal Polypus. *Amer. Jour. of Ophthal.*, 1892, p. 134.

is considered by Gerber[9] as one of the earliest symptoms of orbital involvement.

Ptosis may occur as a result of extension of an inflammatory process from the posterior ethmoidal cells or the sphenoidal sinus to the apex of the orbit. A chronic conjunctivitis or marginal blepharitis may result from the chronic congestion accompanying disease of the sinuses or by infection from the nasal secretions *viâ* the lachrymo-nasal duct.

Laurens[10] has reported a case of *blepharospasm* which was entirely relieved by the removal of synechiæ from the nose together with hypertrophied turbinals.

Affections of the Lachrymal Apparatus Resulting from Diseases of the Neighboring Cavities.

Disease of the lachrymal apparatus has long been recognized as secondary to nasal disease in the majority of instances. The connection is so direct that such an inference is obvious. The most frequently recognized nasal condition to cause lachrymal disease is the obstruction of the lachrymo-nasal duct by hypertrophy or malposition of the inferior turbinal. Serious disturbance of the lachrymal canal, such as periostitis or necrosis with resultant obstruction, is, however, more frequently due to ethmoidal or antral disease, from their close relation anatomically. Fistulæ from the frontal sinus or from an anterior ethmoidal cell may occur in the region of the lachrymal sac, producing a perisaccular abscess and simulating blennorrhea of the sac, and such an abscess has been known to perforate into the lachrymal sac, further complicating the diagnosis. Epiphora is present in practically all cases of involvement of the ocular apparatus from sinus disease. It is often one of the earliest symptoms and when noted indicates the necessity for a careful nasal examination.

Alterations in the Cornea and Sclera Due to Nasal and Sinus Diseases.

The cornea is seldom directly affected by disease of the nasal cavities. Keratitis and corneal ulceration may occur secondary to disease of the lachrymal sac, from a panophthalmitis following orbital abscess, or from exposure in extreme proptosis of the eyeball.

The *sclera* is rarely affected by disease of the accessory sinuses, although injection of the vessels of the bulbar conjunctiva has frequently been noted in frontal sinuitis and the anterior perforating vessels of the sclera may become tortuous.

Oculo-Muscular Disturbances and Accessory Sinus Diseases.

Disturbance of the balance of the extraocular muscles may occur

---

[9]Gerber. Die Complicationen der Stirnhöhlenentzündungen, 1909, p. 207.
[10]Laurens. Affections Nasales et Troubles Oculaires Réflexes. *Annal. d'Oculistique*, April, 1896, p. 241.

from extension of an inflammatory process in an accessory sinus. This may directly involve the muscles themselves, as in insufficiency of the internal recti or by involvement of the nerves which supply the muscles, as they pass along the outer wall of the sphenoidal sinus. The muscle most frequently affected is the external rectus, due to the anatomical position of the sixth nerve supplying it. This nerve passes into the orbit in a groove in the sphenoidal sinus wall, and is likely to be involved in inflammation of the sinus when the sphenoidal wall is thin. A definite diplopia does not occur so frequently as an insufficiency of one or more muscles which may be detected only in the outer portion of the field of fixation by means of the red glass test. Pain may often be elicited in these cases by rotating the eye toward the affected muscle. The imbalance resulting may cause confusion in performing the visual act, vertigo and nausea, and make near work impossible, as the ciliary muscle may be likewise affected.

Intraocular Disease Due to Nasal and Sinus Affections.

Many cases of iritis which in the past have been considered to be due to rheumatism, intestinal autointoxication or of idiopathic origin are undoubtedly due to nasal disease. The author observed one case in particular which, from a careful urinalysis, seemed to be due to intestinal autointoxication. After several days of thorough eliminative treatment with no effect upon the iritis the nose was examined and pus was withdrawn from the anterior ethmoidal cells with the suction apparatus, with the result that all signs of the inflammation disappeared within thirty-six hours.

Involvement of the eye is more likely to occur from infection in a thin-walled sinus or where dehiscences occur in the bony walls, producing direct contact between the lining membrane of the sinus and the orbital periosteum or even the sheath of the optic nerve. Adhesions may occur between the orbital periosteum or optic nerve sheath and the bony sinus walls secondary to inflammation of the latter and these adhesions may become vascularized, offering a direct route for infection of the ocular structures.

Few authentic cases of *uveitis due to sinus disease* have been recorded, which is remarkable considering the close relation existing between the nasal and ocular circulations. Posey[11] suggests that there may be some controlling mechanism which prevents the ocular circulation from participating in the inflammatory conditions, just as there is a control of the intraocular circulation which makes it partially independent of the general circulation.

---

[11]Posey. The Ocular Symptoms of Affections of the Accessory Sinuses of the Nose. *Trans. Sec. Ophthal. A. M. A.*, 1905.

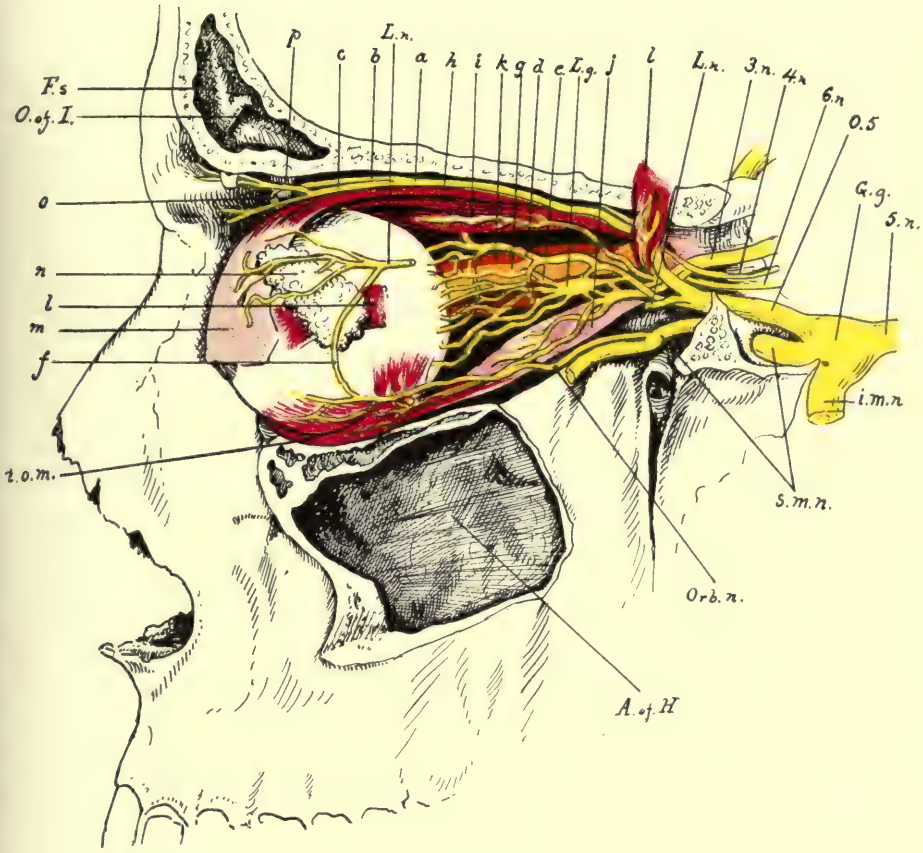


PLATE XVIII

Section of the Left Orbit.

a. Frontal nerve,
b. Supratrochlear nerve.
c. Supraorbital nerve.
d. Nasal nerve,
e. Short ciliary nerves.
f. Loop between orbital and lachrymal nerves.
g. Optic nerve.
h. Levator palpebræ muscle.
i. Superior rectus muscle.
j. Inferior rectus muscle.
k. Internal rectus muscle.
l. External rectus muscle (severed).
m. Tarsal cartilage of upper eyelid.
n. Lachrymal gland.
o. Tendon of superior oblique muscle.
p. Pulley.
i.o.m. Inferior oblique muscle.
L.n. Lachrymal nerve (severed).
G.g. Gasserian ganglion.
5.n. Fifth nerve.
o. 5. Ophthalmic division of fifth nerve.
s.m.n. Superior maxillary nerve.
i.m.n. Inferior maxillary nerve.
Orb.n. Orbital nerve.
L.g. Lenticular ganglion
3.n. Third nerve.
4.n. Fourth nerve.
6.n. Sixth nerve.
A of H. Antrum of Highmore.
F s. Frontal sinus.
O. of I. Orifice of Infundibulum.

A uniformity of opinion amongst observers points definitely to the nasal accessory sinuses as one of the chief sources of *optic nerve disease*. Onodi[12] has enriched the literature of this subject by his valuable studies showing the anatomical relations of the sinuses to the ocular structures.

The orbital walls of the accessory sinuses are extremely thin, the floor of the frontal sinus being thickest. The bony walls between the posterior ethmoidal cells and the canalis opticus are usually of tissue paper thickness, while the sphenoidal walls of the same canal may be from 1-12 mm. thick. The thicker the walls of the accessory cavities, the greater the protection to the orbital cavity, as well as the cranial cavity. Indirect infection of the orbit or optic nerve may occur from one sinus through another where there is a common partition wall, as described by Onodi. Zuckerkandl, quoted by Onodi, has described a communication between the maxillary sinus and the posterior ethmoidal cells and Onodi has seen a similar communication of the antrum with the anterior ethmoidal cells. The frontal sinus has partition walls in common with the ethmoidal cells and the sphenoidal sinus. There may be an opening in the inter-frontal partition forming one large frontal sinus. Either sphenoidal cavity or both may have partition walls in common with the posterior ethmoidal cells of either or both sides. These walls are usually very thin and easily diseased.

The *venous system* is another means of extending infective processes from the nose to the orbit. For example, the frontal sinus veins run along the sinus floor communicating with the vena frontalis or vena supraorbitalis. The anterior and posterior ethmoidal veins empty into the superior ophthalmic vein. There is free anastomosis between the superior and inferior ophthalmic veins and the anterior and posterior ethmoidal veins, and the central retinal vein.

The *papillo-macular bundle of the optic nerve* is the most vulnerable portion of the nerve, due to its high organization and its proximity to the central vessels of the nerve, which are involved in circulatory disturbances arising in the sinuses. This process is thought by some, notably Birch-Hirschfeld[13] to be a toxemia due to venous stasis. Involvement of the papillo-macular bundle is shown by the presence of a central scotoma. This scotoma may disappear with drainage of an infected sinus, or the optic nerve may go on to atrophy. The most dangerous area of the optic nerve is within the canalis opticus, where

[12]Onodi. The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope*, Nov., 1909.

[13]Birch-Hirschfeld. Die Beziehungen der entzündlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.*, Jan., 1909, p. 1.

circulatory or inflammatory disturbances may injure the nerve through pressure, especially this sensitive papillo-macular bundle.

Birch-Hirschfeld[14] in a series of 409 cases of orbital involvement due to sinus disease, noted the occurrence of blindness in 16 per cent. The blindness resulted from antrum disease in 24 cases, from frontal sinus disease in only 6 cases, while disease of the ethmoidal cells caused blindness in 13 cases. In the cases due to disease of the maxillary sinus thrombophlebitis of the central vein of the optic nerve was shown microscopically to have been the immediate cause of the blindness. These statistics emphasize the fact that the methods employed by ophthalmologists in the past have not only proved inadequate but dangerous. Ophthalmologists, notably Kuhnt, have already added much to our knowledge of the diagnosis of disease of the nasal accessory sinuses and have aided in developing operative methods upon these sinuses. It now becomes necessary for the oculist to become proficient in this work himself or to refer such cases to a competent rhinologist.

Diseases of the Orbit Due to Affections of the Nose and Neighboring Cavities.

It is now universally accepted that orbital inflammation is due in almost every instance to extension of a disease process from the accessory sinuses of the nose.

The earliest *symptoms* of orbital involvement are usually swelling of the eyelids, particularly the upper, and widening of the lid aperture. Later the lids may become red and brawny and distinct displacement of the eye occur. The direction in which the eye is displaced gives a general idea of the location of the sinus disease. In frontal sinus disease the globe is pushed downward and outward, in ethmoidal disease outward and sometimes upward and in sphenoidal disease proptosis occurs almost directly forward.

The frontal sinus in Birch-Hirschfeld's series caused orbital disease in 129 cases (29.8 per cent), the maxillary sinus in 89 cases (21.8 per cent), the ethmoidal labyrinth in 83 cases (20.5 per cent), and the sphenoidal sinus in 25 cases (6.1 per cent). In 60 cases (14.7 per cent) more than one sinus was involved, 25 cases showing associated disease of the frontal and ethmoidal cells, 12 cases disease of the ethmoidal and maxillary sinuses and 10 cases showing coincident involvement of the sphenoidal and ethmoidal cells.

Surgical Anatomy of the Frontal Sinus.

The two frontal sinuses lie between the inner and outer tables of the frontal bone, bounded anteriorly by the superciliary eminences, below by the orbit and posteriorly by the cranial cavity. The dimen-

[14]Birch-Hirschfeld, loco cit.

sions of these sinuses vary greatly. Logan Turner[15] gives the following measurements as the average: height, 31.6 mm.; breadth, 25.8 mm.; depth, 18 mm. The smallest sinus which he found had a height of 18 mm., a breadth of 13 mm. and a depth of 5 mm., while the largest had a height of 45 mm., a breadth of 60 mm., and a depth of 25 mm. Loeb's[16] frontal sinus measurements show the antero-posterior diameter to vary from 9 to 33 mm.; the supero-inferior from 14 to 31 mm. and the lateral from 7 to 42 mm.

A vertical septum, approximately in the median line, separates the two cells, although in exceptional instances it is absent. Partial partitions frequently occur, producing irregular recesses which are so frequently the means of continuing a chronic empyema unless recognized and removed radically. The frontal sinus is not present at birth, but begins to develop usually about the beginning of the second year as an extension of the ethmoid cells. It reaches a size sufficient to be recognized as a frontal sinus extending above the supraorbital margin at about the seventh year.

The *orbital wall* is the thinnest, being especially thin at the upper inner angle of the orbit where fistulae most frequently occur in chronic frontal sinuitis. Occasional defects have been found in the orbital wall giving even more direct communication between the orbit and the frontal sinus. Near the median line the floor of the sinus lies contiguous to the ethmoid labyrinth. The *ostium frontale,* by means of which the frontal sinus communicates with the nose, lies at the lowest part of the sinus at its anterior angle near the septum frontale. The ostium is always present, when a frontal sinus exists at all, as it forms a part in the development of the frontal sinus from the ethmoid cells. The ostium varies in size in different cases, which accounts for the fact that some sinuses drain so much more easily than others. Drainage of this cell is also frequently interfered with at a lower point in the hiatus semilunaris where an unusually close approximation of the bulla and uncinate process of the ethmoid occurs, as suggested by Ewing[17] and Sluder.[18]

The *fronto-nasal* duct may also be encroached upon by small ethmoidal cells or even by the large ethmoidal cell which is sometimes found pushed upward into the frontal sinus. These anatomical variations complicate the diagnosis in supposed frontal sinus infections, as

[15]Turner. *Accessory Sinuses of the Nose,* 1902, p. 23.

[16]Loeb. A Study of the Anatomic Relations of the Optic Nerve to the Accessory Cavities of the Nose. *Annals. of Otol. and Rhin.,* June, 1909.

[17]Ewing. Frontal Headaches apparently ocular, but really of nasal origin—their recognition and treatment. *Trans. Am. Ophthal. Soc.,* 1900, p. 60.

[18]Sluder. On the nasal conditions found in these cases, with special reference to an abnormal relation of the uncinate process of the ethmoid to the bulla of the ethmoid. *Trans. Am. Ophthal. Soc.,* 1900, p. 60.

from such cells pus is to be seen directly in the region of the fronto-nasal duct and a probe passed into such a "bulla frontalis," as Zuckerkandl has named it, is naturally thought to be in the frontal sinus itself. These various developmental combinations all unite to make it more difficult to find and probe the fronto-nasal duct, which is so important from the standpoint of diagnosis and treatment.

The *diagnosis of disease of the frontal sinus* depends upon char-

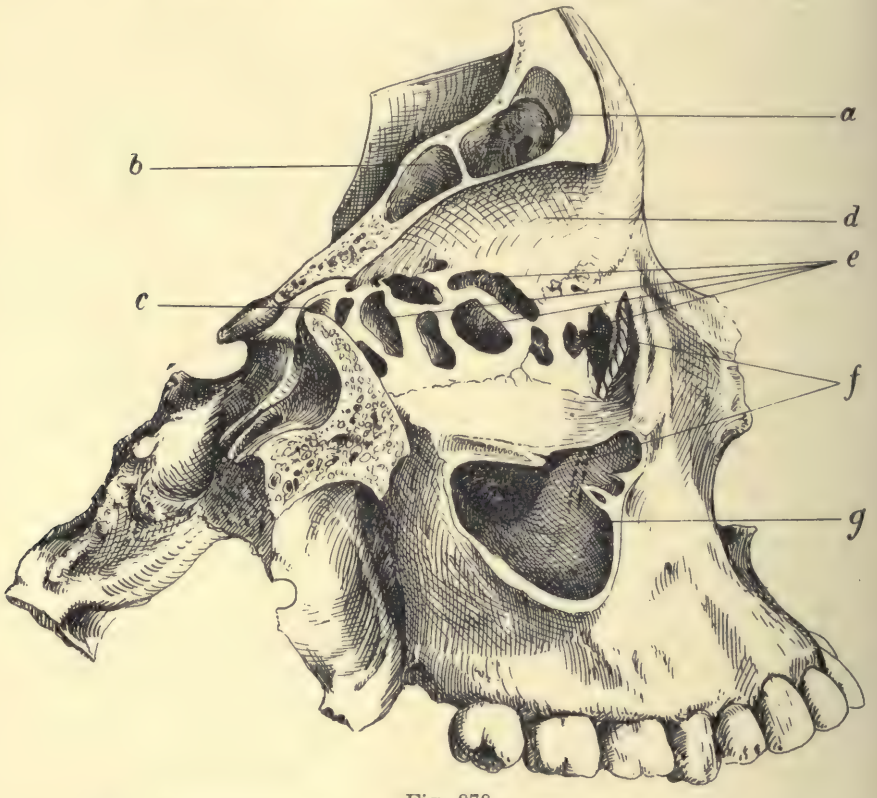


Fig. 878.

View of the Frontal Sinus and Neighboring Cavities in Their Relation to the Orbit.

a, Frontal Sinus; *b*, Anterior Ethmoidal Cell; *c*, Optic Nerve Canal; *d*, Inner Orbital Wall; *e*, Ethmoidal Labyrinth; *f*, Lacrimo-Nasal Duct shown by Thread; *g*, Maxillary Antrum.

acteristic symptoms which are present with greater regularity than are those of the other accessory sinuses.

Acute frontal sinuitis occurs secondary to an acute rhinitis and begins with a sensation of heaviness and pressure above the eye accompanied by malaise and fever.

A *fistula of the frontal sinus* may produce an abscess at the inner

canthus simulating abscess of the lachrymal sac and the diagnosis may be further complicated by perforation into the lachrymal sac.

Certain *diagnosis of empyema of the frontal sinus* may be made when pus follows the passage of a probe into the sinus or is washed from the sinus with a curved cannula, all secretions having been previously removed from the nares. The author's suction pump is useful in cases where for any reason the sinuses cannot be probed.

Suction is obtained by a simple water-pump of the type used in pharmaceutical laboratories for forced filtration. The device is fast-

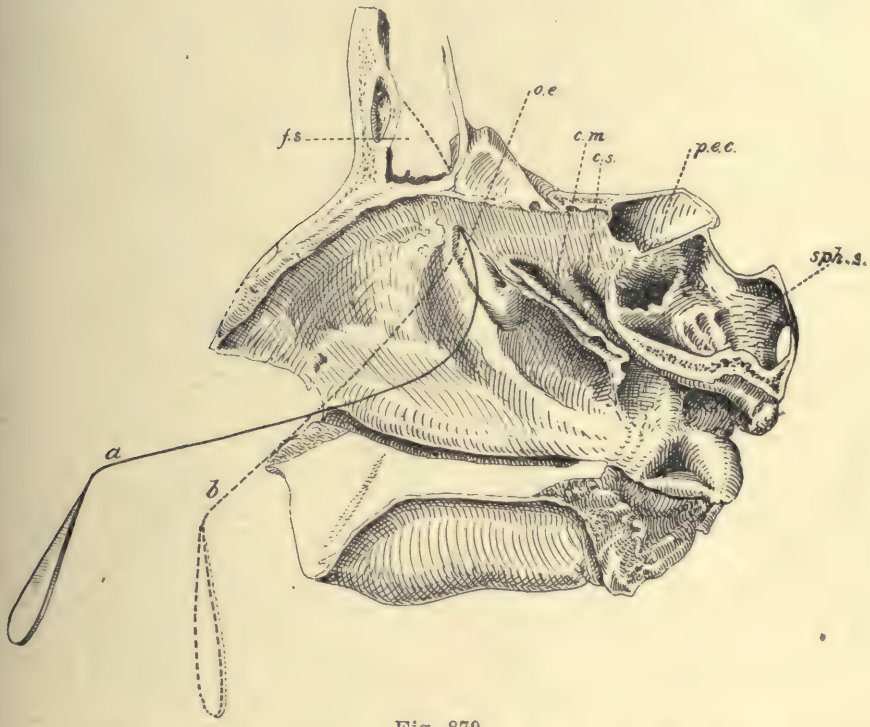


Fig. 879.

View Showing the Two Positions in Probing the Fronto-Nasal Duct. *f, s*, Frontal Sinus; *o, e*, Ethmoidal Ostium; *c, m*, Middle Turbinal; *c, s.*, Superior Turbinal; *p, e, c, Posterior Ethmoidal Cell; sph, s*, Sphenoidal Sinus; *a*, Probe Entering Fronto-Nasal Duct; *b*, Probe within the Frontal Sinus.

ened to a cold water faucet by means of a shower-bath attachment. A large glass bottle is used to catch secretion from the nose and prevent blocking of the pump. A tube with a nasal tip for each nostril is occasionally used, but the single olive-shaped hard rubber tip is more frequently employed, as it is easily adjusted to every shape of nostril, the opposite side being then closed by the finger. The patient is instructed to take a long breath and gently say "hick," holding the soft

palate in the position it is thus made to assume. This closes the nares posteriorly and by turning on the water any desired force may be obtained. The soft palate usually rises without difficulty into its position against the posterior pharynx wall and is then held in place by the force of the suction. Patients who experience difficulty in learning to manage the palate, may try various ways, such as swallowing slowly, sounding a prolonged "EE," or holding the tongue and soft palate in the position required to form the first half of the letter "K," omitting the explosive sound which completes the letter.

The nasal tip should be placed in such a position in the nostril that the opening cannot come in contact with the septum or external wall of the vestibule as the force would be expended at these points only, causing pain and producing no results within the nose. The tip

Fig. 880.
Author's Accessory Sinus Suction Apparatus.

should be pushed firmly into the nostril as the ala may collapse with the negative pressure and close the opening in the tip.

The author finds this water suction pump invaluable in the diagnosis of accessory nasal sinus infections and has met with success also in treating the chronic types, especially in disease of the ethmoidal cells and in cases which for any reason cannot be operated upon. In addition to the mechanical drainage obtained a local hyperemia is induced after the principle of Bier,[19] which is a valuable factor.

As applied in diagnosis of frontal sinuitis, the secretion is carefully wiped away from the middle turbinal and middle meatus and suction used for five minutes, when the secretion will be seen to reappear high up under the middle turbinal. The increased drainage thus obtained is capable in uncomplicated cases of effecting a cure.

[19]Meyer-Schmieden. *Bier's Hyperemic Treatment.* Saunders Co., 1908.

Transillumination of the sinus has a corroborative value but in view of the possibility of error, due to variations in the thickness of the bony walls or periosteum, the finding of a shadow is not conclusive. Skiagrams, however, are of the greatest value, especially in cases with negative nasal findings.

OPERATIVE AND OTHER TREATMENT OF FRONTAL SINUS DISEASES PRODUCING EYE SYMPTOMS.

Empyema of the frontal sinus requires immediate drainage. This may be accomplished by irrigating the cell with a curved cannula, by applications of cocain and suprarenalin to the middle turbinal and middle meatus, by resection of the anterior portion of the middle turbinal, by one of the intranasal operations for enlarging the fronto-nasal duct, or by one of the various radical external operations. Drainage measures are especially indicated where ocular symptoms are present, when delay might mean permanent damage to the ocular apparatus, particularly to the optic nerve.

When the pain of a frontal sinuitis is not relieved by shrinking the middle turbinal tissue with cocain and suprarenalin, a probe should be passed when possible and then a small silver cannula, bent to the same curve as the probe, should follow and the sinus should then be irrigated with a warm, sterile, physiologic, saline solution.

For irrigating the accessory sinuses the author has devised an irrigating apparatus consisting of a three-gallon tank lined with block-tin. Compressed air enters the tank above and forces the warm solution out through a long, block-tin pipe, reaching nearly to the bottom of the tank. This tube connects at the top of the tank with a length of rubber tubing to which is attached a very heavy cut-off, such as is used for compressed air. A small tube four inches long with a truncated cone tip and a bell protector is brazed to the cut-off and forms the connection with the cannula. The force of the stream is thus under perfect control and any desired quantity of the solution may be used. The solution is sterilized and retained at the proper temperature by means of an electric stove set in the base of the tank.

After irrigation the sinus should be dried with a stream of compressed air through the cannula, and argyrol 5 per cent., trikresol 0.5 per cent. or other non-irritating antiseptic forced into the cell from the author's treatment bottle. It will usually be found necessary to resect the anterior third of the middle turbinal before the fronto-nasal duct can be reached with a cannula. This is in itself a great aid to proper drainage as the turbinal is always swollen and boggy under such conditions and acts as a constant obstruction to the outflow of pus.

Ballenger[20] advocates the removal of obstructions to proper drainage in all cases of sinus infection. He has named the region of the hiatus semilunaris, the ethmoid cells and the recessus spheno-ethmoidalis the "vicious circle" of the nose. He also warns against intranasal operations preliminary to radical external operations, as they tend to increase the virulence of the infecting organisms.

In *preparation for the resection of a portion of the middle turbinal* a 4 per cent. solution of cocain is applied by means of a cotton-tipped applicator to the anterior half of the middle turbinal, septum and mid-

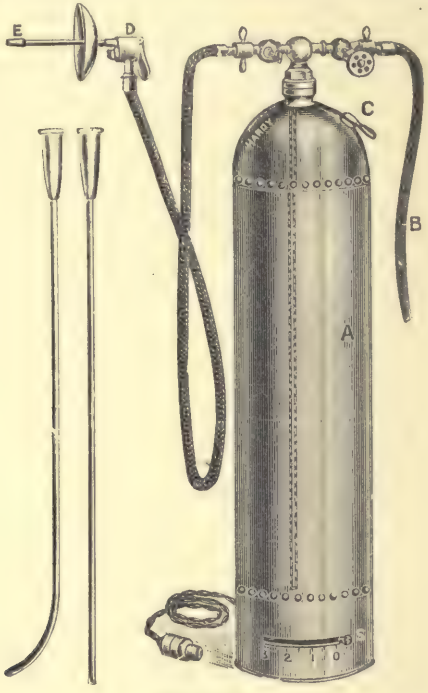


Fig. 881.

Author's Irrigating Apparatus and Cannulæ.

a, Tank; *b*, Compressed air inlet; *c*, Opening for filling and cleansing tank; *d*, Cut-off; *e*, Truncated cone tip to fit cannulæ; *f*, Electric heater.

dle meatus. Five minutes later suprarenalin in 1-1,000 solution is applied, followed by a 10 per cent. cocain solution. In ten minutes anesthesia is usually complete. The anterior attachment of the turbinal is then cut through by means of the Casselberry scissors, Van Struyken cutting forceps or by introducing the Sluder or similar angle knife into the middle meatus and cutting upward and toward the septum through the attachment. The latter method has the advantage that the incision

[20]Ballenger. *Diseases of Nose, Throat and Ear*, 1909, p. 200.

is made under conrol of the eye, the various forceps, scissors, etc., requiring much space and interfering with vision during the operation. The final step consists in the removal of the cut segment of middle turbinal by introducing the bight of a snare, such as the Krause, into the incision and then pushing the loop downward and backward as far as it is desired to remove turbinal tissue. The snare is then closed and

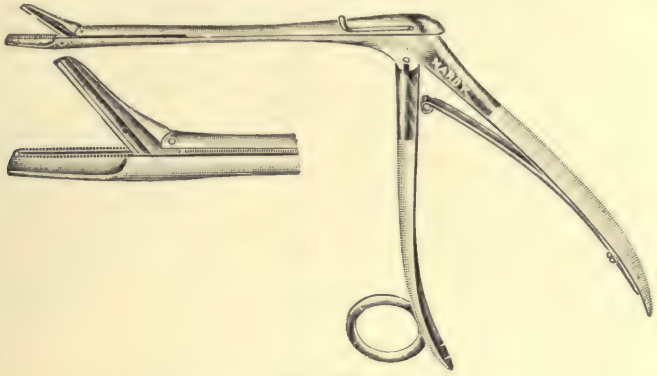


Fig. 882.
Van Struycken Nasal Punch Forceps.

the turbinal cut through. The Holmes scissors, curved on the flat, are designed to cut away the necessary amount of middle turbinal without recourse to the snare.

Ballenger[21] describes a turbinal knife with blunt end and curved cutting edge which he passes into the olfactory fissure and then turns toward the turbinal at the desired point, cutting forward and removing

Fig. 883.
Casselberry's (serrated) Nasal Scissors.

any desired portion. He also makes use of his swivel knife to sever the turbinal from its attachment in favorable cases, introducing the swivel blade at the anterior attachment of the middle turbinal and cutting backward with short strokes until the desired amount is removed. If a

[21]Ballenger. *Diseases of Nose, Throat and Ear*, 1909, p. 150.

part only is to be cut away, the swivel blade is turned downward at the desired point and made to cut its way out below.

All polypi and hypertrophies should be removed from the middle meatus when present, using the Myles or Grünwald punch forceps or sharp curette. The frontal sinus probe should be passed into the sinus after the section of turbinal has been removed, to insure the patency of the fronto-nasal duct. In some instances it may be necessary to cut away one or more of the ethmoid cells about the fronto-nasal duct be-

Fig. 884.
Lack's Knife.

fore the probe can be passed into the sinus. This may be easily done by cutting through the cells with the Sluder knife and removing the debris with the Myles punch or a sharp curette.

After-Treatment of Frontal Sinus Operations.

These operations, as with all operations on the nose, are best performed in hospital, the patient being prepared by administering forty grains of Merck's soluble lactate of calcium in five grain doses to insure proper coagulation of the blood. After the operation, packing of the nose is only exceptionally required, and thus the only disagree-

Fig. 885.
The Sluder Knife.

able feature of nasal operations is avoided. The patient is at once put to bed and remains there until the following day. If necessary to operate in the office, a Stevenson nasal tampon of gauze and compressed cotton may be used, as the disturbance of the homeward journey is likely to cause a hemorrhage. These tampons are kept in readiness for the hospital cases also and the interne instructed in the proper manner of applying them in case of necessity. The tampon may be covered by folding a piece of rubber tissue over it before insertion, to prevent adhesion of the gauze outer layers to the wound.

The patient may usually be allowed to leave the hospital in 24 or 36 hours and is then treated daily at the office by means of sterile physiological saline irrigations through a cannula passed into the sinus. Next, the sinus is dried by compressed air, and 5 per cent. argyrol, 1 per cent. nargol, 0.5 per cent. trikresol, etc., may be injected into the cell and left there, the patient holding the head backward for a few minutes to insure the retention and distribution of the antiseptic.

Should the above measures fail to relieve the pain and especially

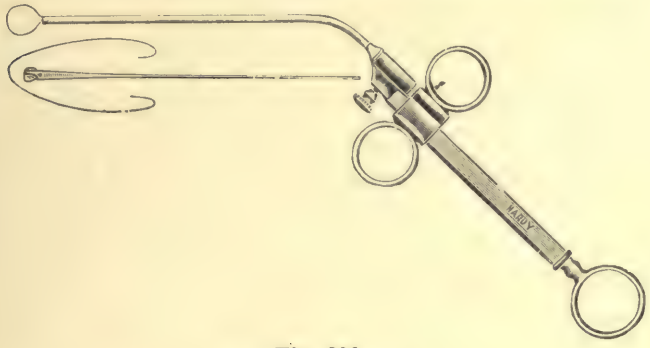


Fig. 886.
Krause Nasal Snare.

the ocular symptoms, a larger communication between the nose and frontal sinus is indicated. This may be obtained by enlarging the fronto-nasal duct intranasally or by the simple trephine operation externally.

Ingals' Operation for Opening the Frontal Sinus.

Probably the most ingenious operation for opening the frontal sinus intranasally is that devised by E. Fletcher Ingals.[23] The necessary instruments are a pilot with detachable handle, pilot-burr, shield,

Fig. 887.
Ballenger Swivel Turbinotome.

packer, applicator, special pilot-burr and guard, and a self-retaining drainage tube.

As a safeguard against cutting into the fossa ethmoidalis a ligature is attached to the distal end of the spiral-tube-shield and the burr is made to cut as far forward as possible. Röntgen photographs are necessary in each case to avoid anatomical dangers and to be sure that

[23] Ingals., *Jour. A. M. A.*, May 9, 1908.

the pilot is in the fronto-nasal duct. Ingals has operated on most of his cases in his office but prefers the hospital as being safer.

The anterior end of the middle turbinal is resected and polypi, deflections or other nasal obstructions are removed several weeks before the operation proper. Cocain is the usual anesthetic, but in exceptional cases ethyl chloride has been used and where given after the probe has been passed and all is in readiness to complete the operation, its effect lasts a sufficient time for the purpose. Anesthesia is

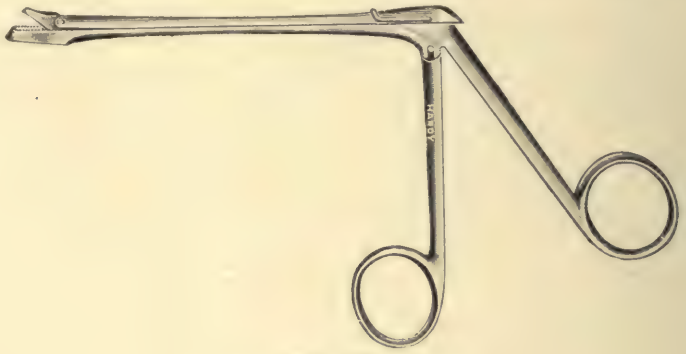


Fig. 888.
Myles Nasal Punch Forceps.

attained by passing into the frontal sinus a curved silver canula attached to a syringe containing a 20 per cent. solution of cocain in 1-1,000 suprarenalin solution. This is injected drop by drop and flows downward along the fronto-nasal duct around the canula.

The operation is described in Ingals' own words as the best expression of his meaning:

"Before beginning the operation all instruments are sterilized, the spiral tube shield is slipped over the burr, and the burr attached to the chuck of a dental engine. The spring ends of the drainage tube are bent back so as

Fig. 889.
Stevenson's (Bernay) Nasal Tampon (one-half size).

to make its open end about a centimeter in diameter, and then they are gently pressed together and enclosed in a No. 2 gelatin capsule. This is then dipped into melted paraffin, melting at about 110 degrees, whereby it is covered by a thin film that will prevent it from dissolving in the fluids in the nose for about five minutes after its introduction. Unless covered in this way, the capsule would soften in about twenty seconds, which would not be quite time enough for the introduction of the tube.

As soon as the patient is properly anesthetized, and the pilot probe introduced, the handle is removed from the pilot (or probe), the hollow burr is slipped on over it and carried up to the lower orifice of the nasofrontal duct, the shield being pushed up with it so that the mucous membrane of the naris will not be injured by the rapid revolutions of the flexible cable.

The electric current is now turned on, and the burr is gently pressed upward. It usually cuts its way into the frontal sinus in two or three seconds. I usually draw it back and press it up again two or three times to make sure that the canal is perfectly free, then withdraw it and the pilot.

The patient must now be cautioned not to blowthe nose for three or four days because of the danger of causing emphysema about the eyelids, as in other cases where the ethmoid cells have been opened.

If it has been necessary to use a pilot with more than the normal curve, one with the normal curve is now introduced, and the burr is passed in again to insure a proper curve of the canal to fit the gold drainage tube. The naris should next be mopped thoroughly with vaselin on a swab of cotton. The packer is then introduced well into the enlarged canal, and through it

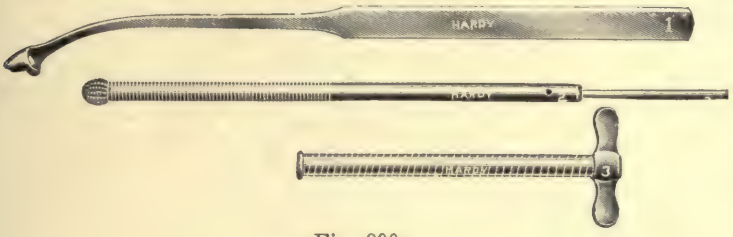


Fig. 890.

1. Modified Burr Carrier.
2. Modified Burr.
3. Flexible Spiral Sheath (Ingals).

the frontal sinus is packed with a strip of one-inch sterile gauze saturated with a 20 per cent. solution of chlorid of zinc. This is allowed to remain about five minutes. The packer is then drawn out about a centimeter, so as to bring its end as nearly as possible to the lower end of the enlarged canal, and the gauze is then withdrawn, through it, thus cauterizing the whole length of the wound but avoiding any cauterization of the mucous lining of the naris.

The spiral tube shield is next passed over the stem of the applicator, and then the gold drainage tube is slipped on the end of the instrument and introduced into the enlarged drainage canal. The spiral tube shield is

Fig. 891.

4. Drainage Tube Introducer.
5. Gold Drainage Tube (Ingals).

pushed up against the lower end of the gold tube to hold it in position, the applicator is withdrawn and the operation is finished.

If the drainage tube does not pass in easily it must result either from the burr not having been carried into the frontal sinus or else from the pilot having had a curve different from the normal. In either case the tube should be withdrawn and the burr passed in again over a pilot of normal curve. I have sometimes packed the naris afterward with gauze to prevent possible bleeding, but I do not think this necessary, and it is objectionable if not needed. I have in no case seen bleeding of more than an ounce of blood during or following the operation, and usually there are not more than two or three drams."

The *after-treatment* consists in the use of cleansing solutions such as physiological saline solution and the injection of 10 per cent. to 20

per cent. argyrol through a silver catheter into the sinus, when the secretion continues. Ingals' experience has been that the size of the canal resulting from this operation is ample for almost all cases of frontal sinus suppuration and proves that curettement is usually unnecessary. Acute infections may occur in the sinus after this operation during the course of an acute rhinitis but the adequate drainage rapidly results in healing and such attacks are no more to be charged to the operation than an acute attack in a normal sinus.

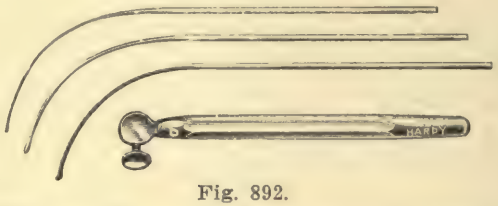


Fig. 892.
Frontal Sinus Probes and Handle (Ingals).

The *advantages of the intranasal operations* are many. The deforming scar of the external operation and the longer period of after-treatment incapacitating the patient are avoided. A general anesthetic is usually unnecessary and should it be necessary in special cases to operate externally an important part of the external operation has already been accomplished.

Halle's Operation.

Halle[24] was the first to devise a method of cutting away the heavy

Fig. 893.
Gauze Packer. Bulb for Medication through Gold Drainage Tube (Ingals).

spina nasofrontalis of the superior maxilla by means of electrically driven burrs and drills thus obtaining a wide communication between the nose and frontal sinus.

R. H. Good[25] proposes to reach the frontal sinus intranasally by means of specially made chisels and a curved rasp.

---

[24]Halle. Externe oder interne Operation der Nebenhöhleneiterungen. *Berlin Klin. Wochenschr*, Nos. 42 and 43, 1906.
[25]Good. *Jour. A. M. A.*, Aug. 31, 1907, pp. 753-754.

This operation has the advantage of simplicity over those of Halle and Ingals, which require a much more expensive equipment both in the first cost and in maintenance.

The middle turbinal is removed, after proper anesthesia has been obtained with cocain crystals and adrenalin 1-1000. The larger chisel is then used to cut away the processus uncinatus. The frontal sinus duct is then located and 10 per cent. cocain in adrenalin 1-1000 is injected into the frontal sinus with a syringe and a properly curved cannula. The *protectors* are of three sizes, the largest one possible being inserted into the sinus.

The larger chisel is now used to cut away the frontal process of the

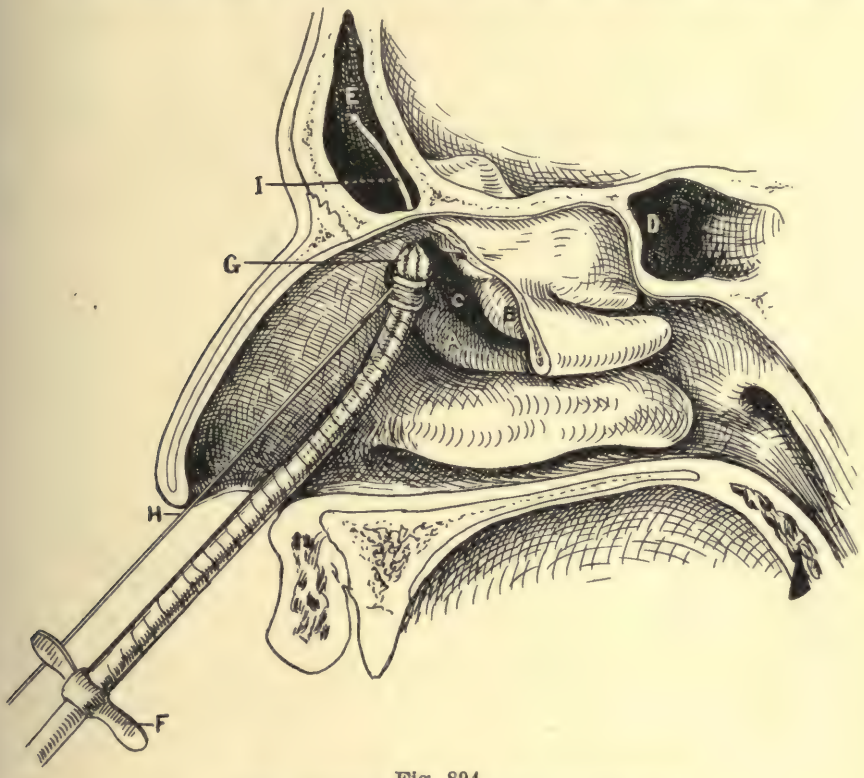


Fig. 894.
Ingals' Intranasal Frontal Sinus Operation.

superior maxillary bone, the spina of the frontal bone and the anterior medial wall of the ethmoid. The removal of these structures is facilitated by forceps and curettes. (The protectors are of brass and pliable on the flat. They serve to prevent wounding of the internal table of the skull. The chisel edges are dull and tapering, to avoid cutting into the os planum of the ethmoid.) At this point the narrow rasp, which is curved so as to enter the sinus easily, is introduced. The sharp teeth are on the concave surface, while the convex surface is perfectly smooth. If the rasp will not enter the sinus the smaller chisel is used to enlarge the opening. Good keeps a prepared skull before him in operating, the better to judge of the possibility of entering the orbit or injuring the lacrimal bone. A finger in the orbit controls the rasp which is used to cut away the spina frontalis and fronto-ethmoidal cells. It should be made to cut forward and outward, not directly

forward, and care should be taken not to withdraw the rasp so far as to injure the septum, which would result in troublesome adhesions. The sinus may be curetted with flexible curettes and packed with gauze saturated with carbolized petrolatum.. This packing is removed in 24 hours and no after-treatment employed except the application of silver nitrate to exuberant granulations.

External Frontal Sinus Operations.

External operations on the frontal sinus are indicated in those cases which have not improved after intranasal drainage or where it has been impossible to pass the guiding probe into the sinus. In this class also are the severe types, especially the streptococcic and pneu-

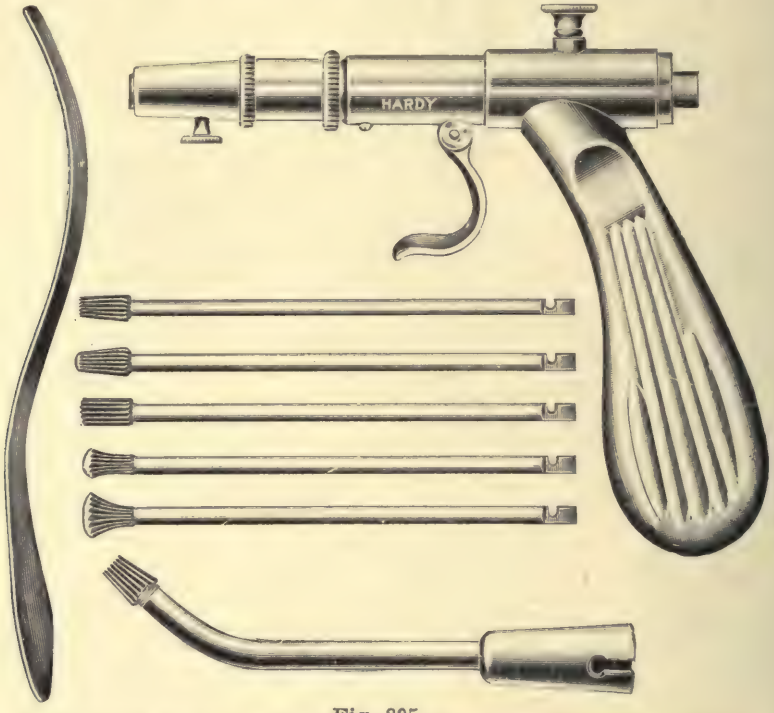


Fig. 895.
Instruments for the Intranasal Frontal Sinus Operation (Halle).

mococcic infections which rapidly destroy tissue, and the cases with cranial or orbital involvement or where fistulae are present.

The earliest frontal sinus operation was the simple opening of the cell over its most prominent point and was performed only in cases of perforation of the sinus wall or when swelling over the sinus area indicated abscess or new growth.

In simple trephining of the frontal sinus, Kuhnt[26] enters at a point found by drawing an imaginary line passing through the supraorbital

[26]Kuhnt. *Ueber die entzündlichen Erkrankungen der Stirnhöhlen*, Wiesbaden, 1895.

notches and a second line from the anterior crista lachrymalis, perpendicular to the first, the point of entrance being at their crossing. Mallet and chisel, or electric trephine may be used. This method is used only in acute cases and for diagnosis, the radical operation is at once undertaken where extensive disease is found.

Even at as late a period as 1887 the indications for opening the frontal sinus were intracranial pressure, dilatation of the cell walls or dislocation of the eyeball. The more recent operations upon the frontal sinus are divided by Hajek into three classes. In the first class

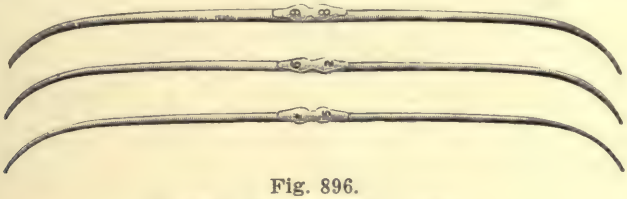


Fig. 896.
Frontal Sinus Probes (Good).

are grouped those operations in which the whole or a part of the anterior sinus wall is removed. The second class is represented by the Jansen operation for removing the floor of the sinus and the third class includes those methods in which both the anterior and inferior walls of the sinus are removed.

In all operations upon the frontal sinus and orbit, according to Czermak and Elschnig,[27] the anatomical parts to avoid are the supraorbital and infraorbital branches of the fifth nerve, nervus frontalis, optic nerve and third, fourth and sixth nerves in the fissura orbitalis

Fig. 897.
Frontal Sinus Protectors (one-half size) (Good).

superior and inferior. The attachments of the ocular muscles about the foramen opticum, the pulley of the superior oblique and the inferior oblique attachment are also danger points, as well as the fascia supporting the lachrymal gland, the internal palpebral ligament forming the lid attachment to the orbital margin at the inner canthus, the lachrymal sac and duct.

Operation of Nebinger-Praun.[28]

The incision is made along the orbital margin from the naso-

[27] Czermak and Elschnig. *Augenärzt. Operationen*, Vol. I.
[28] Nebinger-Praun. Die Stirnhöhleneiterung. *Inaug. Dissert.* Erlangen, 1890.

frontal suture to the supraorbital notch and the skin and periosteum elevated from the anterior sinus wall, the latter procedure being facilitated by a vertical incision about 4 cm. long, in line with the frontal vein. The anterior wall is then removed with chisels, the cell cleansed and curetted and the naso-frontal duct enlarged and drainage left at the juncture of the vertical and horizontal incisions.

Fig. 898.
Frontal Sinus Chisels (Good).

Operation of Hajek-Luc.[29]

This operation is also known as the Ogston-Luc method. The incision is made along the brow which has been sterilized but not shaved and extends usually from the temporal end of the brow to the root of the nose. A second vertical incision begins at the median end of the horizontal incision and extends upward as far as the upper limits

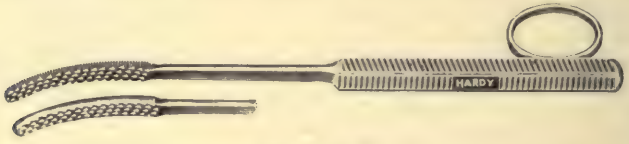


Fig. 899.
Frontal Sinus Rasps, Right and Left (Good).

of the sinus. The skin and periosteum are then elevated, leaving a triangular area of bone exposed. The sinus is now entered with the chisel slightly to the outer side of the median line and a part of the anterior wall cut away. Diseased membrane and bony septa are removed and the fronto-nasal duct enlarged by cutting away part of the anterior ethmoidal cells. Originally Luc used a rubber tube drain into

Fig. 900.
Frontal Sinus Drain (Good).

the nose, but later iodoform gauze was employed, the external wound being immediately closed. Ballenger recommends leaving the rubber tube in position for several weeks or until all discharge ceases. There is less disfigurement in this operation than in the more radical pro-

[29]Luc. Contribution à l'étude des suppurations du sinus frontal. *Arch. international de Laryngol.*, Bd. VII, No. 27.

cedures, but the liability to relapse due to insufficient removal of diseased tissue is a disadvantage.

Operation of Kuhnt.

Kuhnt[30] advocates the removal of the entire anterior wall of the frontal sinus with all of the lining membrane. The incision begins at the median end of the eye-brow and extends to its outer third. A second incision begins at the median end of the first and extends directly upward to the upper limit of the sinus. The entire anterior wall,

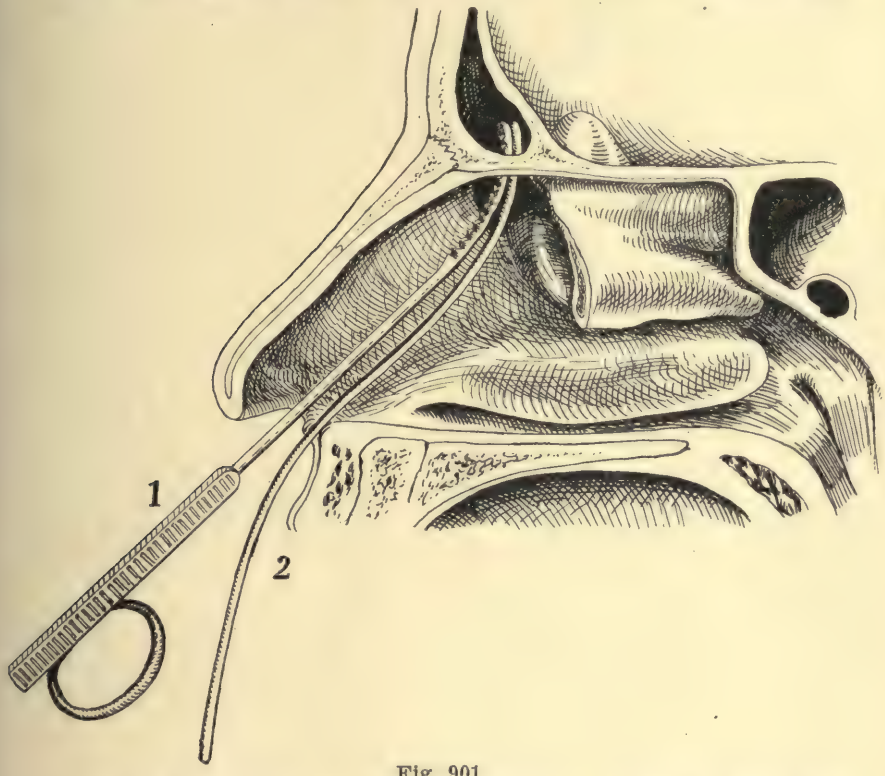


Fig. 901.

The Good Intranasal Frontal Sinus Operation. 1, Frontal Sinus Rasp; 2, Protector.

together with all bony septa within the sinus is now cut away with chisel and bone forceps and the bone edges smoothed. The entire lining membrane, including that of the upper part of the nasal duct, is now removed and the wound sutured, space being left for a large drainage tube. The fronto-nasal duct closes by granulation and prevents reinfection from the nose.

[30]Kuhnt. *Ueber die entzündlichen Erkrankungen der Stirnhöhlen*, Wiesbaden, 1895.

Cure results in almost every case, but great disfigurement follows and the anterior ethmoidal cells which are always coincidentally involved are not removed. To avoid these disadvantages the Kuhnt and the Hajek-Luc operations may be combined. In this operation the en-

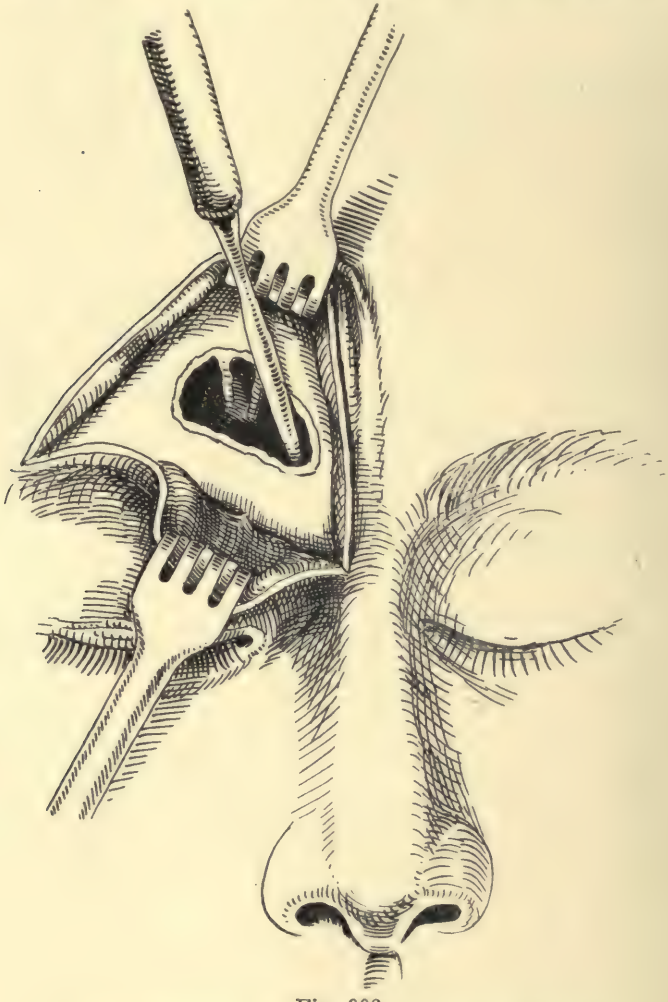


Fig. 902.
The Hajek-Luc Radical Frontal Sinus Operation.

tire anterior wall is removed, the anterior ethmoidal cells are opened and the rubber tube gives drainage into the nose, the external wound closing primarily.

Burchardt[31] modifies the Kuhnt operation for chronic frontal

[31]Burchardt. Eine Modifizierung der Kuhntschen Operation bei chronischer Stirnhöhleneiterung. *Archiv f. Laryn.*, 1904, Bd. 15, p. 495.

sinuitis as follows. After the entire anterior wall of the sinus has been removed down to a narrow strip at the supraorbital margin, all pus, granulations, necrotic bone, bony partitions and irregularities are removed, the fronto-nasal duct is enlarged and a large drainage tube passed through it into the nose. The entire external wound is then closed.

In 4-5 days the tube is removed and when the wound has healed externally a pressure bandage is applied to bring about healing between the skin and periosteum of the anterior wall and that of the posterior wall. The reaction is less and the long-continued packing is avoided. In closing the wound the periosteum is carefully sutured with the skin to cover the bone surface left, insuring a slight scar. The best results are in shallow sinuses. Less time in operating is required and quite as thorough a result is attained as in Killian's operation.

Operation of Jansen.

Jansen[32] makes a curved incision from the outer orbital margin below and parallel to the eye-brow and extending to the root of the nose. The periosteum of the roof of the orbit is now detached and the bony floor of the frontal sinus cut away. The lining membrane of the sinus is curetted and all diseased tissue removed. This route allows of thorough removal of the infected ethmoid cells but has the disadvantage of less thorough exenteration of the frontal sinus itself.

Operation of Killian.

Killian[33] was the first to propose the idea of leaving a bridge of bone, periosteum and skin at the orbital margin to preserve the contour of the brow. At first he was dissatisfied with the solid bridge and attempted to resect it at either end, replacing it at the close of the operation. The case in which this was tried, however, showed downward displacement of the bridge when inspected a year later.

After various changes Killian gives the following as his improved technic. The patient undergoes a thorough general examination before operation. Before the operation is begun the patient receives hypodermically gm. 0.01 of morphine and all sinuses which contain pus are irrigated and the nasal chamber cleansed. Next a tampon is introduced into the posterior portion of the naris, especially the middle meatus. A general anesthetic is now given and the field of operation sterilized. The eye-brow is not shaved. The skin incision begins at the temporal end of the eye-brow and is continued through the brow

[32]Jansen. Zur Eröffnung der Nebenhöhle der Nase bei chronischer Eiterung. *Fraenkel's Archiv. f. Laryng.*, Bd. I, 1894, p. 135.

[33]Killian. Die Killiansche Radicaloperation bei chronischer Stirnhöhleneiterungen. *Archiv. f. Laryng. u. Rhinol.*, Bd. XIII, Heft 1, p. 84.

to its median end when it is made to curve downward along the side of the nose at the middle of the frontal process of the superior maxilla.

The periosteal incision is made in two parts. The first is made parallel to the orbital margin and 5 or 6 mm. above it, and of the same extent as the horizontal portion of the skin incision. The second incision begins near the pulley of the superior oblique muscle, 5 to 6 mm. below the first periosteal incision, and curves downward following the

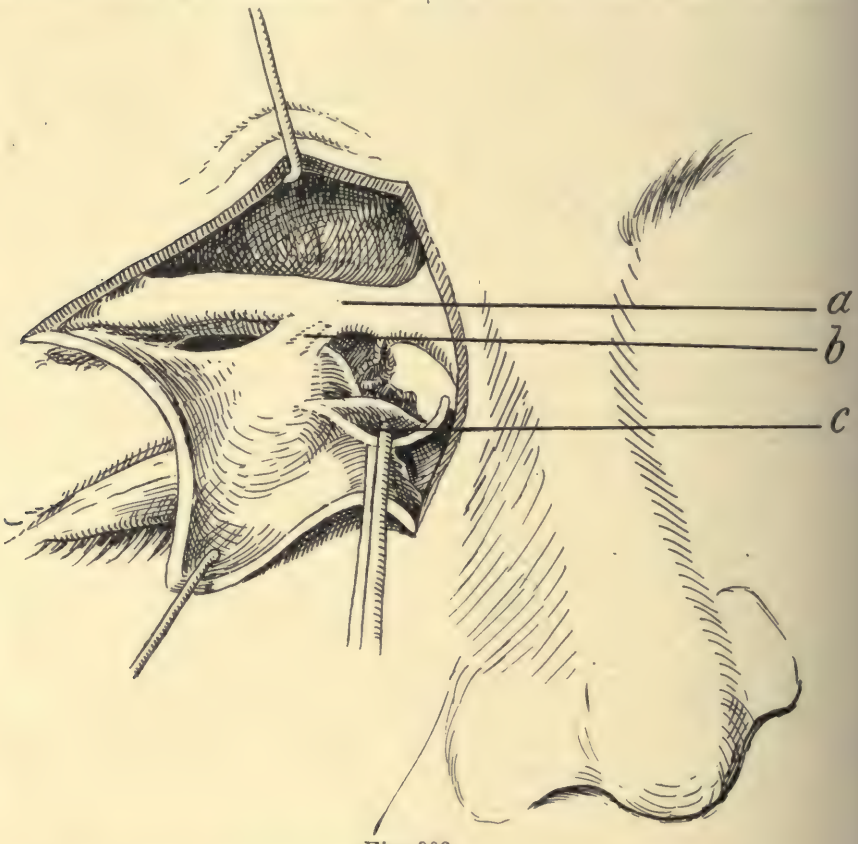


Fig. 903.

The Killian Radical Frontal Sinus Operation, Showing the Bridge *a;* Flap of Nasal Mucous Membrane, *b;* and Trochlea Attached, *c.* (After Czermak and Elschnig.)

skin incision along the middle line of the nasal process of the superior maxilla. The frontal sinus is now opened either above or below the bridge of bone thus outlined. After the chisel has cut away sufficient bone a probe is used to outline the extent of the cavity, the probe passing between the lining membrane and the bony wall. This avoids opening the membranous sinus early in the operation, exposing the wound to infection.

The periosteum is now elevated over the entire extent of the sinus, the soft tissues are retracted upward and a furrow is cut along the line of the upper periosteal incision with a chisel. Next, the entire anterior wall is removed with chisel and bone forceps and all septa cut away. The lining membrane is now removed thoroughly with curettes, not forgetting the inner surface of the bridge.

The operator next stands behind the patient's head and with an electric headlight to illuminate the sinus, a chisel is used to remove the floor along the line of the lower periosteal incision. The entire floor may now be removed with a curved bone forceps. The periosteum is now elevated from the lower incision to the margin of the nasal bone and from the lower orbital border, lachrymal sac and orbital roof. The frontal process of the superior maxillary bone is then removed with chisel and bone forceps. The nasal mucus membrane is carefully preserved. This makes possible the removal of the orbital roof in the deeper portions, together with temporal and ethmoidal projections of the sinus. The nasal membrane may now be detached from the frontal process and the frontal cells of the ethmoid removed with the Hartmann punch, and a sharp curette. A smooth walled space is thus formed between the nose and the frontal sinus. The anterior end of the middle turbinal may now be removed after first removing the tampon from the middle meatus and if necessary, the ethmoidal cells and their lamellae may be cut away and the sphenoidal sinus reached.

A flap may now be made by incising the nasal membrane at the margin of the nasal bone, carrying the incision upward, backward, then downward and laying the flap outward to cover the wall of the enlarged nasal duct, leaving a large, permanent opening. The field is then freed of debris and flushed with sterile physiological saline solution. Iodoform powder is blown into the sinus and a perforated rubber tube drain is inserted reaching from the temporal wound angle to the nasal entrance. It is held in position, together with the mucous membrane flap, by gauze packed from the nose. The external wound is accurately closed and lightly covered with gauze and bandaged.

The patient is put to bed on the well side and instructed not to blow his nose, but to remove the secretion by hawking it backwards into the throat. The wound is dressed daily, the nasal tampon is removed on the second day, the drainage tube on the third or fourth day and the sutures on the fourth or fifth day. A protective dressing leaving the eye uncovered is continued for a short time longer. No nasal irrigation is allowed. 2.5 per cent. silver nitrate solution may be applied to the sinus walls through the nose to keep down exuberant granulations.

Hajek[34] modifies the Killian operation as follows. He does not attempt to save the nasal mucous membrane after the removal of the processus nasalis as he considers it unnecessary and difficult. The removal of the orbital floor is made much easier by separating the orbital periosteum and retracting the soft tissues instead of leaving the trochlear attachment. He has never seen any injury to the superior oblique muscle, nor has an ophthalmologist been able to locate any interference

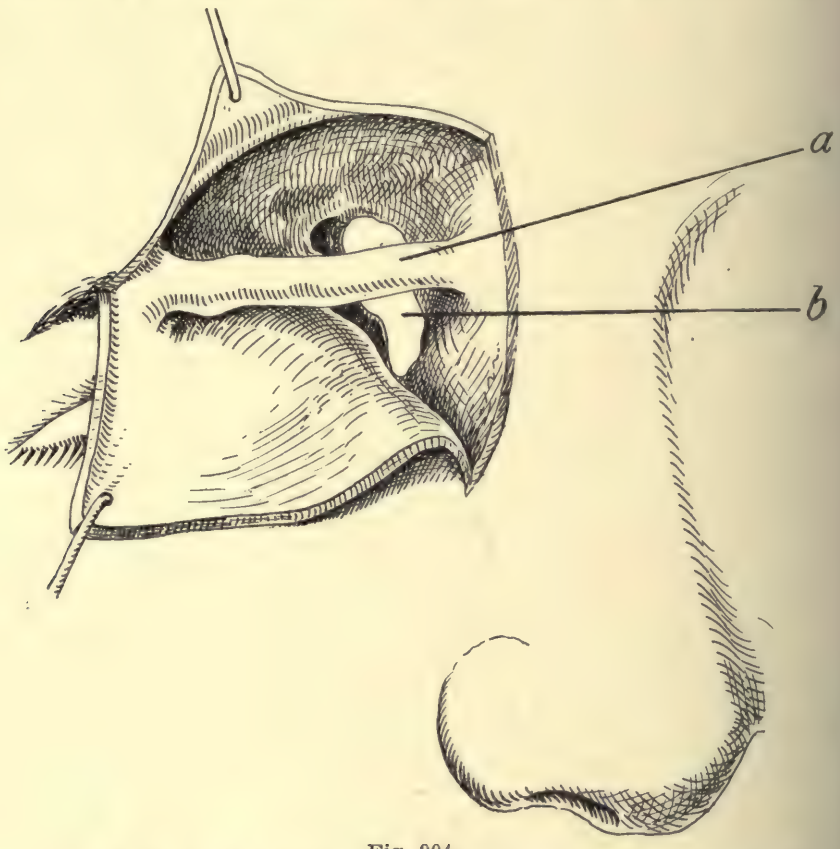


Fig. 904.

The Hajek Modified Killian Radical Frontal Sinus Operation, Showing the Bridge, *a;* with Trochlea Detached and Opening through the Ethmoidal Cells, *b*. (After Czermak and Elschnig.)

with its function in the seven cases which he has operated even as early as eight days following operation. The approach to the anterior ethmoid cells is also facilitated by removing the trochlear attachment.

---

[34]Hajek. Ueber die Operationmethoden bei den Stirnhöhlenentzündungen. *Zeitschrift f. Augen.*, June, 1907, p. 567.

Richards[35] in all cases of frontal sinus suppuration, associated with ethmoidal or other sinus infection accompanied by polypi, advocates the removal of the anterior frontal sinus wall below the supraorbital ridge with as much of the floor and nasal process of the superior maxillary bone as seems necessary to gain access to the sinus. Obliteration of the sinus follows and is attained by prolonged packing. The process is disagreeable and requires prolonged after-treatment but is, according to Richards, reasonably certain to effect a cure.

Coakley removes the anterior sinus wall above the supraorbital ridge, obliterates the fronto-nasal duct and then the sinus by packing.

Lathrop, quoted by Richards, suggests a modification of the Ogston-Luc operation. A short incision is made below the inner end of the eyebrow and the sinus opened at this point. The nasal portion of the frontal sinus floor is removed by curettes with all of the ethmoidal cells about the ostium frontale. The anterior sinus wall is not disturbed.

Coffin[36] uses the open method where the frontal sinus is alone involved and occasionally where the ethmoid cells are also infected. Gauze pack is used through a small opening in the anterior sinus wall and continued until the sinus obliterates. The opening is enlarged if needed to reach all parts of a large sinus and if necessary the nasal process of the superior maxillary bone is removed as in the Killian operation to reach ethmoid labyrinth.

Prince[37] proposes a radical frontal sinus operation which while thorough, gives a good cosmetic result. He first introduces a post-nasal plug. If a considerable septal deflection is present he corrects it and removes the anterior end of the middle turbinal with his forceps. These forceps are also used to remove the ethmoidal cells where polypi are present. After clipping the eyebrow and proper cleansing of the region with soap and antiseptics, a skin incision is made beginning at the junction of the frontal, nasal and maxillary bones and extending along the middle of the eyebrow. He does not extend the incision downward along the side of the nose on account of the objectionable scar resulting. The incision through the periosteum parallels the skin incision. The periosteum is now elevated from the roof and inner orbital wall, the trochlea being carefully detached with the periosteum. The orbital contents are retracted and an opening made in the frontal sinus with a rounded chisel. Prince's modified Kerrison rongeur is now

---

[35]Richards. My Personal Experiences with Empyemata of the Frontal Sinus with Deductions Therefrom. *Trans. Amer. Laryn. Ass'n*, 1905, p. 125.

[36]Coffin. The Choice of Operation for the Relief of Chronic Empyema of the Frontal Sinus and the Anterior Ethmoidal Cells. *Trans. Amer. Laryn. Assn.*, 1905, p. 116.

[37]Prince. *Trans. Section Laryng. A. M. A.*, 1908.

used to remove the anterior portion of the frontal sinus floor. Where the nasal process of the superior maxilla obscures the ethmoid cells, as much as necessary is removed and the os planum is removed as far back as the anterior ethmoidal foramen. Forward biting forceps now remove the remainder of the frontal sinus floor. The middle turbinal forceps are now passed into the nose and with the finger for a guide a free opening is made through what remains of the ethmoid cells up to the frontal sinus. The rongeur removes the internal naso-frontal spine through the nose. The septa in the frontal sinus are removed and the mucous membrane thoroughly curetted with a special burr.

Diseased areas of the sinus membrane are cauterized with pure phenol or trichloracetic acid. Prince views the cavity through a sinuscope having an electric lamp placed on the side of the instrument (Rochester Surgical Appliance Co.). Where necessary the ethmoidal cells may be removed and the sphenoidal sinus opened through the nose as the previous operative work has afforded plenty of room. The cut edges of the periosteum are united with pyoktanin catgut, especial care being given to replacement of the trochlea. The skin wound is sutured carefully with horsehair and sealed with collodion on a strip of gauze. The after-treatment is slight, consisting in wiping out the cavity with cotton saturated with 25 per cent. alcohol. The patient must not blow his nose but is instructed to aspirate the secretions into the naso-pharynx.

Arnold Knapp[38] has modified existing operations for dealing with orbital subperiosteal abscesses secondary to nasal accessory sinus disease. He considers that intranasal treatment and drainage are of use in the acute form only. When perforation from an infected sinus occurs into the orbit, it is usually through the lamina papyracea of the ethmoid and occasionally through the frontal floor. The pus burrows under the periosteum, causing exophthalmos. It is an advantage to remove part of the middle turbinal a few days before the external operation, although Killian claims that the virulence of the infection is thereby increased.

Under ether a skin incision is made along the orbital margin parallel to and just below the line of the eye-brow, then down along the inner orbital wall and side of the nose to the orbital floor. No postnasal plug is necessary. The periosteum is next incised at the orbital margin, above and in line with the skin incision along the nose and raised with a sharp elevator. The orbital contents with the sac which must be carefully detached, are then retracted. The pulley of the superior oblique also requires care in detaching as serious disturbance

[38] Arnold Knapp. The Surgical Treatment of Orbital Complications in Disease of the Nasal Accessory Sinuses. *Sec. Oph. A. M. A.* 1908, p. 163.

of the ocular muscle balance may result. A blunt periosteotome may be used from behind forward to dislodge that portion of the periosteum which supports the pulley. If instead of the usual rough depression the pulley is attached to a bony spine, the latter may be pried off with a flat chisel and will reattach when the wound is closed.

The next step is to remove the floor of the frontal sinus with chisels and hammer. Diseased tissue and septa are then removed with curettes. Next the nasal process of the superior maxillary, the lachrymal bone and os planum of the ethmoid are removed. Knapp here uses a curved shovel-shaped retractor and a flat one shaped like a tongue depressor to retract the orbital contents from the field.

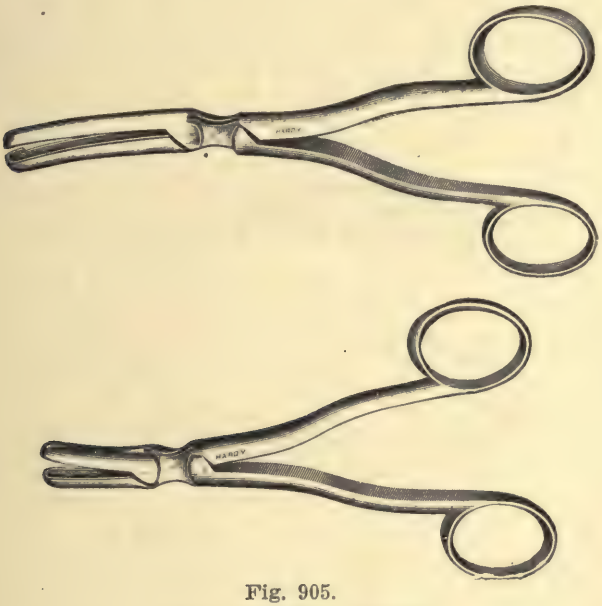


Fig. 905.
Prince's Turbinal Forceps.

Jansen's forceps, Hartmann's conchotome and curettes are employed to remove the cells of the ethmoid, keeping below the anterior ethmoidal foramen which marks the level of the cribriform plate of the ethmoid and remembering that the ethmoid becomes broader posteriorly. The rest of the middle turbinate may now be removed and the sphenoid reached if necessary. In case the frontal sinus is very extensive the upper lip of the original incision may be forcibly retracted upward and a portion of the anterior wall removed, leaving a bony bridge covered with periosteum as in the Killian operation. Knapp does not suture the external wound although it would seem of some advantage to at least suture the horizontal wound along the orbital margin, leaving a

gauze wick in the lower wound. Gauze is also packed into the ethmoidal region to provide drainage toward the nose and to prevent hemorrhage. The drainage at the inner orbital angle is retained from 7-10 days and the nasal cavity is left undisturbed. There is usually diplopia for a few days but this entirely disappears even in the lower part of the field as shown by colored glass and candle tests. Knapp describes his operation as a modification of those of Kuhnt and Jansen.

OSTEOPLASTIC OPERATIONS ON THE FRONTAL SINUS FOR THE RELIEF OF EYE SYMPTOMS.

The first to suggest the osteoplastic resection of the anterior wall of the frontal sinus was Czerny.[39] His procedure consisted in making a curved incision over the glabella with the convexity downward, out-

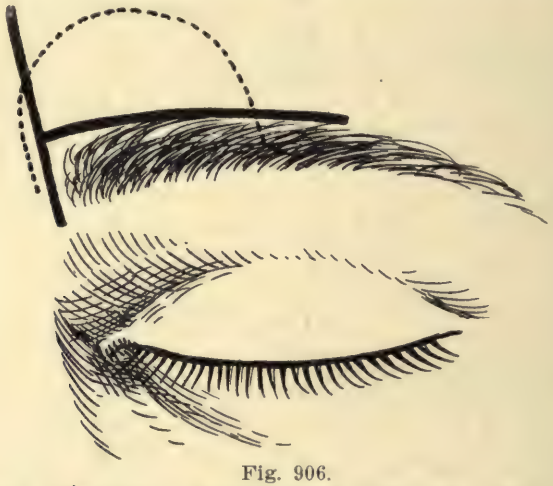


Fig. 906.

Golovine's Osteoplastic Frontal Sinus Operation. Heavy Black Lines show Skin Incisions. Dotted Line shows Bone Flap.

lining a flap with the base in the middle of the forehead. After extending the incision down to the bone the latter was cut through by means of chisels along the line of the incision and the whole lifted upward, exposing the frontal sinus.

Practically the same method was used by Volkovitch who presented a patient thus operated upon at the Sixth Congress of Russian Physicians held in Kyeff, April 25, 1896. Golovine[40] also in 1895 and independently of Czerny, devised an osteoplastic method of opening the frontal sinus. The skin incision is made along the upper border of the

[39]Czerny. *Archiv f. Klinische Chirurgie*, Vol. 50, part 3, 1895, p. 544.

[40]Golovine. Lesions of the Frontal Sinus. *Whitman's Translation Archives of Ophthal.*, May, 1898, p. 294.

median half of the eyebrow and is about 4 cm. long. At the median end of the first incision a second incision is made obliquely to the first following the line of the corrugator muscle of the eyebrow. The two incisions, when completed, appear as the supine letter ⊣, the cross-arm of the ⊣ lying obliquely in the median line (Fig. 906). The soft tissues down to the periosteum are now retracted upward and a curved incision 2 cm. high is made through the periosteum, the base occupying the inner third of the supraorbital ridge. A groove is now made in the frontal bone along the line of the periosteal incision. Next the bone flap is cut through along the groove with a thin, flat chisel, held obliquely and is then raised and reflected downward permitting of a thorough curettement of the interior of the sinus. Drainage is left from the sinus into the nose and the flap replaced and sutured. Golovine also reports excellent results from the application of steam for thirty seconds at a sitting to destroy the lining membrane of the frontal sinus in chronic cases.

THE MAXILLARY SINUS AND ITS SURGICAL ANATOMY.

The maxillary sinus, or antrum of Highmore, is the largest of the nasal accessory sinuses. It lies in the superior maxillary bone, its roof, in which we are especially interested, forming the floor of the orbit, its median wall facing the nose, its anterior wall forming the facial surface of the superior maxilla, and the posterior walls bounding the pterygoid fossa and at the inner upper angle bordering on the cranial cavity.

Loeb[41] gives the maxillary sinus measurements as follows: Antero-posterior diameter 17-42 mm., supero-inferior 17-42 mm., lateral 8-33 mm. The distance from the optic nerve varied from 7 to 25 mm.

The antrum is roughly pyramidal in shape, the base being formed by the nasal wall. This wall is the thinnest where it forms part of the middle meatus, being in this region partly membranous.

The accessory ostium of the antrum lies in this membranous region. The only practical importance of this area is found in its lack of resistance, should an artificial opening be necessary when the natural opening is inaccessible. However, the possibility of entering the orbit from this point is so great that this route to the antrum is seldom employed. The natural ostium of the maxillary sinus opens into the lower portion of the hiatus semilunaris in the middle meatus of the nose. As seen from the antrum it is small and round or oval in shape and lies in the upper part of the wall, its high position above the floor rendering drainage of the cell difficult. The size of the ostium varies. In one case where it was found to be 19 mm. long it occupied the entire

[41]Loeb. A Study of the Anatomic Relations of the Optic Nerve to the Accessory Cavities of the Nose. *Annals. of Otol., Rhin. & Laryn.*, June, 1909.

hiatus. The remainder of the naso-antral wall is of bone, varying in thickness from 3 mm. or more at the base where it meets the floor of the nose, to almost paper thinness in the upper part of the inferior meatus where the diagnostic puncture is best made.

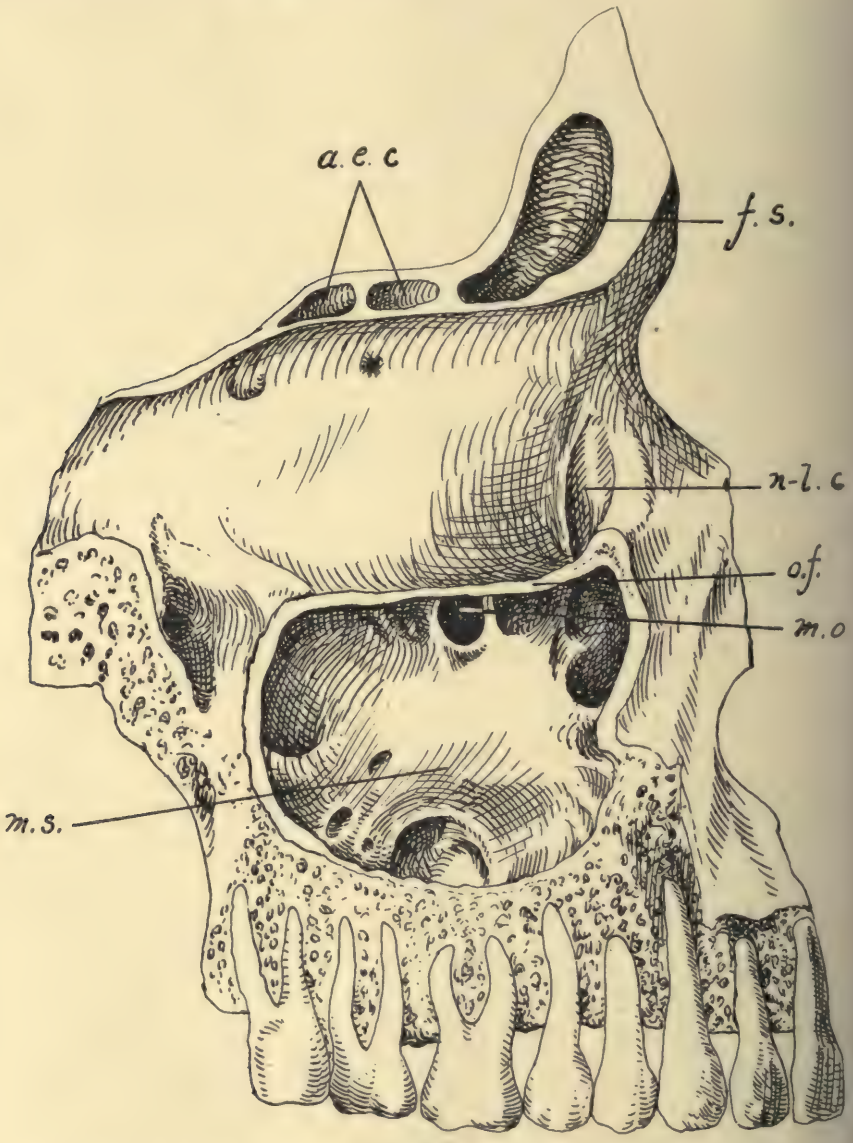


Fig. 907.

Relation of the Maxillary Sinus to the Orbit. *o. f.*, Orbital Floor; *m. s.*, Maxillary Sinus; *m. o.*, Maxillary Ostium; *n. l. c.*, Naso-lacrimal Canal; *f. s.*, Frontal Sinus; *a. e. c.*, Anterior Ethmoidal Cells.

The roof of the maxillary sinus is the thin orbital plate of the superior maxilla and contains the canal of the infraorbital vessels and the superior maxillary nerve. This canal often presents as a ridge on the antral roof and should be avoided in operations as it is very thin. The roof of the antrum has also been found to contain congenital dehiscences.

The floor of the antrum is closely related to the alveolar process of the superior maxilla and is frequently encroached upon by the roots of the second bicuspid and first molar teeth. The alveoli of these teeth, in the event of their being diseased, offer a route for entering the antrum by means of a drill. The variation in thickness of the alveolar process and the fact that drainage occurs into the mouth together with the probability of re-infection from the mouth, are the serious objections to this route.

The maxillary antra are subject to as great variation in size, shape and relative position as the frontal sinuses previously described.

The maxillary sinus is lined by a thin layer of muco-periosteum which is continuous with the lining membrane of the middle meatus of the nose. There are few mucous glands and the epithelium is of the ciliated type.

Diagnosis of Maxillary Sinus Infections.

The subjective symptoms of disease of the maxillary sinus are so variable as to be of little value. Pain and local tenderness are frequently absent in well-marked cases of antrum infection. The presence of secretion in the middle meatus anteriorly or even posteriorly in certain cases of unusually close application of the tip of the middle turbinal to the lateral nasal wall is significant of empyema of one or more of the cells emptying into the middle meatus, the frontal and maxillary sinuses and the anterior ethmoidal cells.

The sinus may be irrigated through the natural or an accessory ostium, or through an artificial opening made by a trocar in the antral wall of the inferior meatus. The ostium maxillare may frequently be found by means of a fine silver probe having 1 cm. of the tip bent at right angles to the main axis of the probe. The probe is passed into the nose with the bent end up and when opposite the hiatus semilunaris it is turned downward into the hiatus and moved up or down in an effort to locate the ostium. It may be necessary to vary the angle of the tip to the probe before the opening can be entered. An unusually narrow hiatus, due to close approximation of the bulla ethmoidalis to the uncinate process of the ethmoid and hypertrophy, or unusual position of the tip of the middle turbinal, may interfere with the passage of the probe. An accessory ostium is occasionally found under the middle third of the middle turbinal.

When the correct angle has been found with the probe, a small silver canula is bent to a corresponding angle and passed into the ostium in the same way or with the tip turned downward as the space permits.

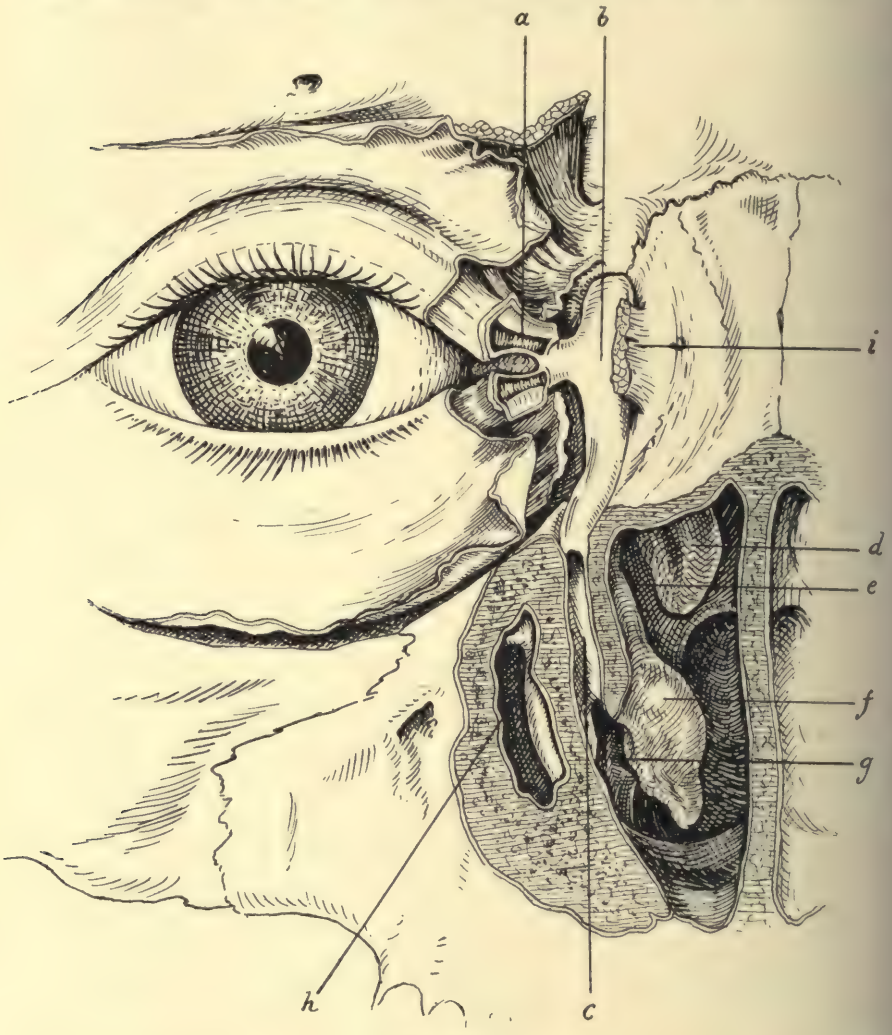


Fig. 908.

Relations of the Eyeball to the Lachrymal Apparatus and the Nose.

a. Lachrymal canaliculus.
b. Lachrymal sac.
c. Lachrymo-nasal duct.
d. Middle turbinate bone.
e. Middle meatus of nose.
f. Inferior turbinate bone.
g. Inferior meatus of nose.
h. Antrum of Highmore.
i. Tendo oculi.

The canula may now be connected with the author's irrigating apparatus and the cell flushed with physiological saline solution. The presence of secretion in the return flow from a nostril previously cleansed establishes the diagnosis of antral disease.

When for any reason it is impossible to reach the natural opening, an artificial opening may be made preferably with a curved trocar such as the Myles.

Dickson[42] has devised an instrument which he calls the "In Situ

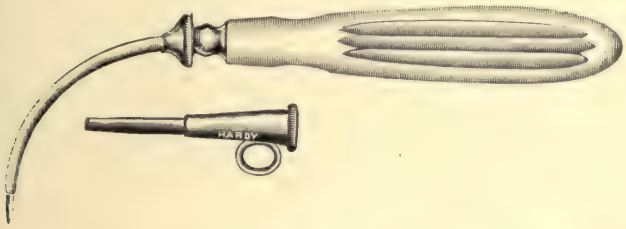


Fig. 909.

Myles Antrum Trocar and Author's Attachment for Irrigator.

Trocar." The handle is long and affords a firm grasp. The trocar portion is curved and several curved canulæ, each having a rounded hump near the distal end to retain its position with the antrum, are furnished with the outfit. The discomfort of frequently inserting a sharp trocar is thus avoided by leaving the canula in situ and merely connecting it with the irrigating apparatus at each treatment.

Where the antral wall of the inferior meatus is too thick to admit of puncture and various points along the wall have been tried in

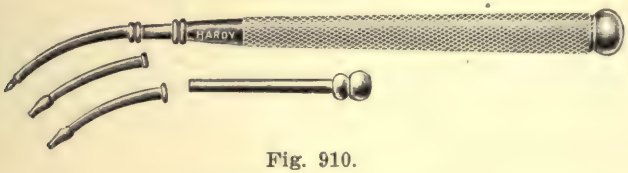


Fig. 910.

Dickson's Antrum Trocar.

vain, an opening may be made through the middle meatus. The safest point in this region is below and somewhat posterior to the uncinate process of the ethmoid. Here one usually finds the membranous area of the middle meatus which offers only slight resistance to the trocar. The possibility of penetrating the orbit is, however, much greater in this region as the outer wall of the middle meatus frequently curves toward or joins the orbital plate of the superior maxilla.

---

[42]Dickson. In Situ Antrum Trocar. *Laryngoscope*, May, 1910, p. 562.

Treatment of Diseases of the Antrum of Highmore.

Maxillary sinus therapy is generally directed towards securing permanent drainage, by irrigation, operations or both.

Irrigations may be carried out by means of the author's irrigating apparatus, a double valve rubber bulb syringe, a gravity irrigator with double valve rubber bulb inserted in the long rubber tube to increase the pressure, or an ordinary piston syringe. One of these various devices is connected with the canula which has previously been passed into the antrum and one or more pints of a warm, sterile, physiological, saline solution is forced through the cell. When the fluid returns from the cell entirely clear, the head is bent forward and, with the diseased side uppermost, compressed air is forced through the canula to dry the interior of the sinus. Should it be necessary to use a medicament, argyrol, 10 per cent., nargol, 1 per cent., zinc chloride or silver nitrate,

Fig. 911.
Author's Treatment Bottle.

0.5 per cent., xeroform, iodoform or formidine powder may be introduced by attaching one of the author's treatment bottles containing the particular solution or powder desired, to the canula and applying compressed air from the usual cut-off.

This form of treatment suffices for practically all recent cases. Chronic antrum discharge, however, is seldom controlled by this method as there is usually present disease of the lining membrane, periosteum or underlying bone which will yield only to the radical removal of the diseased tissue with perfect drainage and aeration of the cell.

OPERATIONS ON THE ANTRAL WALLS.

The earliest conservative method of entering the antrum is that devised by Sir Astley Cooper, and is frequently called the alveolar route. The second bicuspid or first molar tooth, whose roots frequently extend to the antrum floor, is first removed and then an opening is

drilled through the alveolar process into the antrum. It has the disadvantage that a tooth must be sacrificed and so is chiefly used where disease of the tooth possibly affecting the antrum is suspected. The opening is small and requires a prothesis to prevent its closing and the antrum is constantly exposed to re-infection from the mouth.

In cases where the naso-antral wall is very thick or the Cooper method would necessitate the removal of a sound tooth, an opening may be made in the canine fossa with chisel or trephine and maintained with a prothesis. Patients who cannot afford the time for treatments may easily be taught to irrigate the antrum through such an opening.

Parker[43] proposes to enter the antrum by removing the anterior two-thirds of the inferior turbinal and drilling an opening through the naso-antral wall which is then enlarged by Grünwald forceps and the Sonnenkalb antrum punch. He considers a large opening necessary.

Bishop[44] presents an instrument for drilling through the naso-

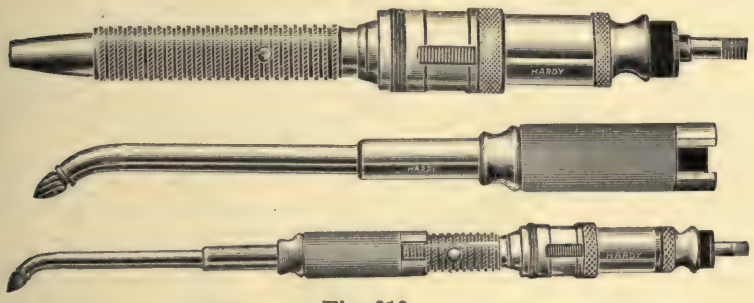


Fig. 912.
Bishop's Antrum Trephine.

antral wall, consisting of a sleeve bent at an angle of 50 degrees, a flexible shaft into which the burr is screwed and the whole fitting the handle of a Victor drill outfit. An opening of any size is easily cut through the naso-antral wall.

Myles[45] advocates a conservative operation on the maxillary sinuses which consists in removing as much as possible of the naso-antral wall in the inferior meatus by means of curved chisels which cut going in and coming out, rongeur forceps and the electric trephine. In some instances part of the inferior turbinal is removed, together with the naso-antral wall in the middle meatus. Malleable-handle curettes are used to remove diseased tissue and one-half inch iodoform gauze is used to pack the cavity. The after-treatment is by irrigation.

---

[43]Parker. Treatment of Empyema of the Antrum of Highmore. *Jour. Minnesota State Med. Assn.*, Nov. 15, 1907.

[44]Bishop. An Instrument which facilitates the Removal of the External Nasal Wall. *Laryngoscope*, Nov., 1909.

[45]Myles. The Maxillary Sinus. *Trans. Amer. Laryn. Assn.*, 1905.

Leland[46] makes a plea for a thorough trial of conservative methods in dealing with maxillary sinus disease. After correction of septal deviations, removal of an enlarged ethmoid bulla or uncinate process and of hypertrophies in the middle meatus, he makes a large opening into the antrum through the middle meatus with a hook similar to Hajek's but stronger, and with a broader blade. This opening may be

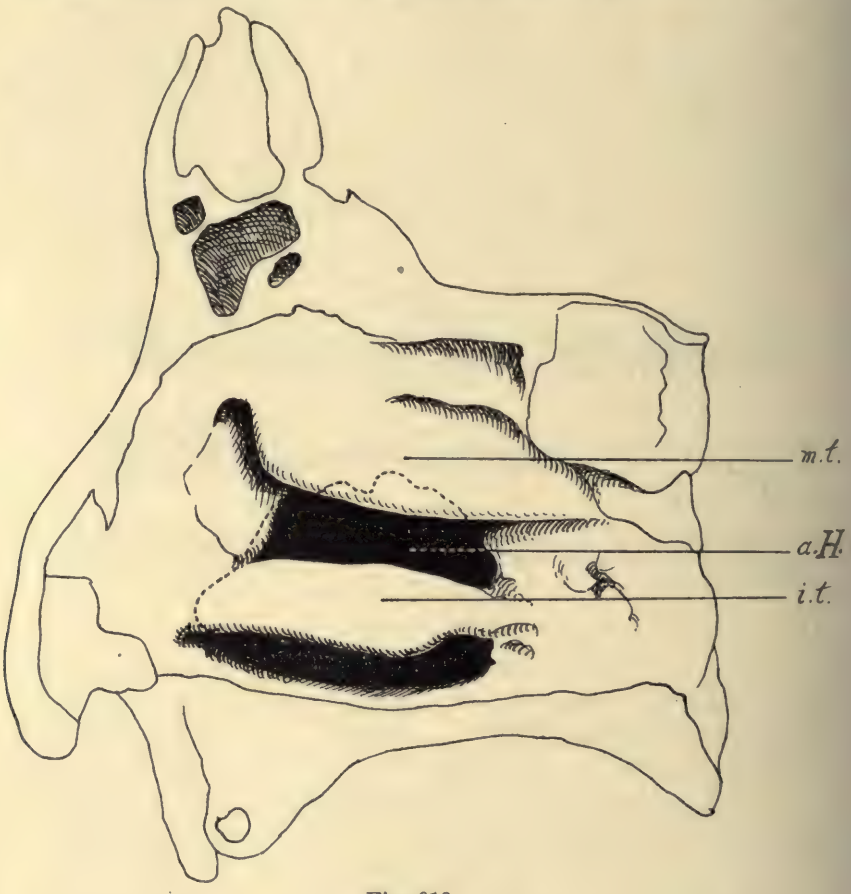


Fig. 913.

Modified Mikulicz Intransal Operation upon the Antrum of Highmore. *m. t.*, Middle Turbinal; *a. h.*, Antrum of Highmore; *i. t.*, Inferior Turbinal Reattached. (After Sluder.)

enlarged with cutting forceps. The inferior turbinal, the most important for nasal respiration, is thus left intact. The opening is kept free from granulations by forceps and caustics, and the antrum irrigated. The patient is instructed to cleanse the sinus frequently by turning the

[46]Leland. The Maxillary Sinus. *Trans. Amer. Laryn. Assn.*, 1905.

head to one side to bring the opening to the lowest point and forcibly blowing the nose.

Sluder[40a] has modified the Mikulicz operation for removing the wall of the inferior meatus intranasally. The inferior turbinal is detached with scissors as far back as its posterior fourth or fifth and pushed upward out of the operative field. The lateral wall of the inferior meatus is next removed and the detached inferior turbinal pushed downward to the nasal floor to make room for the removal of a portion of the antral wall of the middle meatus. After removing as much as desired of the naso-antral wall, the detached turbinal is replaced and

Fig. 914.
Antro-Nasal Chisel. Right and Left (Stein).

reattachment takes place in the nasal process of the superior maxilla. The turbinal is retained in position by means of cotton or gauze tampons or by sutures. Sluder has operated upon fifty-three cases and has never seen the bone fail to unite and has never observed any degeneration or hypertrophy of the inferior turbinal following the operation. The advantages, from a physiological standpoint, of leaving the inferior turbinal, are obvious, especially where it has been necessary to sacrifice the greater portion of the middle turbinal.

Stein[47] suggests the removal of the naso-antral wall by means of an instrument shaped like a narrow spoon with the tip of the bowl cut

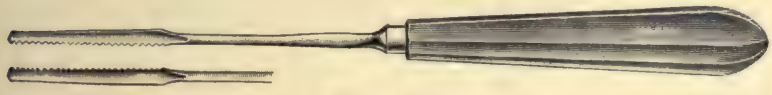


Fig. 915.
Antrum Saws. Right and Left (Vail).

off and notched in a V. One point of the V-shaped end is forced through the naso-antral wall at a point just within the pyriform process with the concavity of the instrument directed toward the nasal floor. By depressing the handle the instrument cuts through the thin wall of the middle meatus and by raising the handle it can be made to cut downward through the inferior turbinal at any desired point. The instrument is now removed and re-entered at the original point but with the

---

[40a]Sluder. A modified Mikulicz operation, etc. *Laryngoscope*, Dec., 1909. p. 906.

[47]Stein. A Rapid and Thorough Method of Opening into the Maxillary Antrum in Selected Chronic Cases. *Laryngoscope*, Feb., 1910.

concavity upward and is made to cut through the antral wall as close to the floor as the bone thickness permits. No account seems to be taken of the nasal portion of the lachrymal duct. However, a second method similar in detail to the first, but confined to that portion of the wall in the inferior meatus, is also suggested and this, of course, would successfully avoid the lachrymal duct.

Vail[48] presents an operation for the removal of the nasal wall of the maxillary antrum intranasally. The antrum wall is punctured at

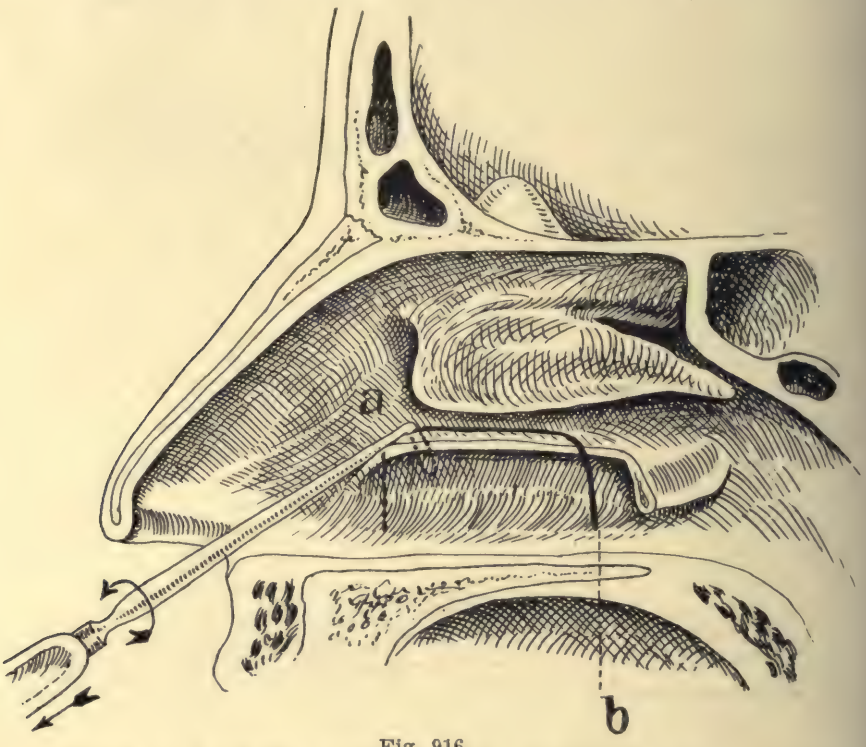


Fig. 916.

Method of Intranasal Removal of the Naso-Antral Wall. *b*. Point where Knife is Introduced; *a*, Point where Knife is Turned to Cut Downward along Dotted Line. (After Ballenger).

the middle of the inferior turbinal with a strong, two-edged bistoury and the blade forced backward and forward to enlarge the opening. A blunt saw curved on the flat and 4 mm. in diameter is then introduced with the teeth forward and aided by the shallow curve, is made to cut out a round button including the middle third of the inferior turbinal and the naso-antral wall. Any loose mucous membrane is

[48]Vail. An Original Method of Opening the Antrum of Highmore Intranasally with Exhibition of New Instruments. *Laryngoscope*, Jan., 1908.

trimmed away with scissors and the wound packed. Vail suggests that in case polypi are found in the antrum and a complete curettement is necessary, the canine fossa may be opened under local infiltration anesthesia and the entire cavity exposed, a sort of reversed Caldwell-Luc operation. A grooved saw was first invented by Pynchon for the removal of low spurs, a fact, however, unknown to Vail at the time he devised his saws. An important point in this operation is the preserva-

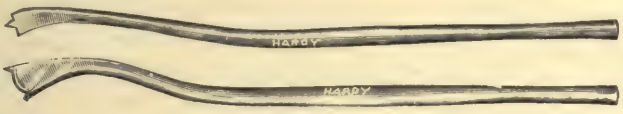


Fig. 917.
Antrum Chisels (Corwin).

tion of the important anterior end of the inferior turbinal which regulates the blood supply of the turbinal erectile tissue, according to the humidity, temperature and barometric pressure of the air inhaled.

Ballenger,[49] under local anesthesia, removes the anterior half of the inferior turbinal with his right-angle knife. The knife enters the turbinal at the middle point and cuts through it to its attachment to the nasal wall, and is then drawn forward following the line of attachment, removing the anterior half. The knife is next made to cut

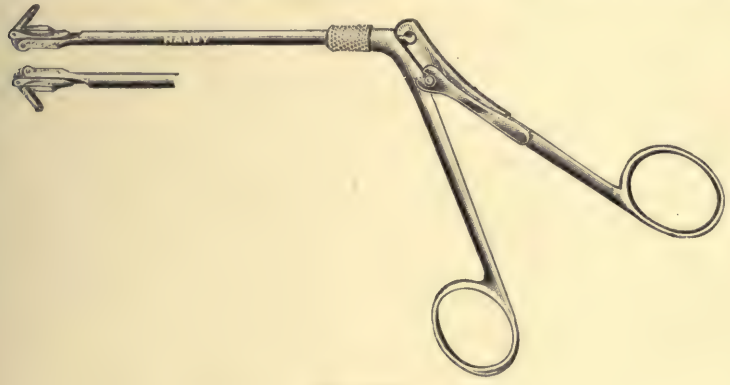


Fig. 918.
Reversible Antrum Punch (Ostrum).

through the naso-antral wall at the posterior limit of the antrum and an upward incision is made as high as desired. The knife is then pulled forward, making an incision parallel to the nasal floor and then avoiding the lachrymo-nasal duct a downward incision is made. The reverse knife is now entered at the posterior incision from which it is made to cut forward as close to the floor of the nose as the thickness

[49]Ballenger. *Diseases of Nose, Throat & Ear*, 1909, p. 221.

of the antral wall will permit. The thickest portion of the wall at the nasal floor may be removed with bone forceps. Iodoform gauze is used to loosely pack the cavity for twenty-four or forty-eight hours and later exuberant granulations are controlled with caustics.

Corwin has designed a pair of curved chisels to remove a similar section of the naso-antral wall. (Fig. 917). Ostrum uses his forward cutting forceps (see Fig. 918) to remove the wall, especially the anterior portion which is the most difficult to reach.

Roe[50] has devised a strong punch forceps for the intranasal removal of the naso-antral wall. There are two forms, one with the male blade entering the antrum for cases where the antrum floor is above the nasal floor and the other with the female blade entering the antrum to be used when the antrum floor is below the level of the floor of the nose.

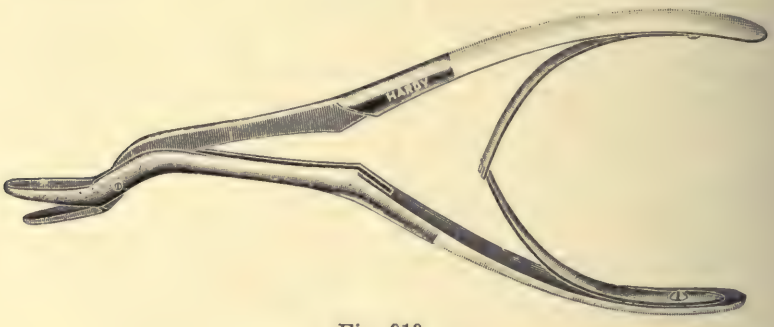


Fig. 919.
Antrum Punch (Roe).

RADICAL OPERATIONS ON THE MAXILLARY SINUS.

The radical operation for disease of the maxillary sinus was first performed by Lamorier[51] in 1768. It was later revived by Desault and modified by Küster.[52] Küster considers that the only serious objection to opening the facial wall of the maxillary sinus is the exposure to food and infectious material from the mouth. He avoids this by making a flap of muco-periosteum from the first bicuspid to the first molar tooth and reflects the flap upward. He then removes sufficient of the facial wall of the antrum to admit the little finger which is used to palpate the interior of the cell to locate diseased tissue, carious roots of teeth, etc. After the necessary curettement the sinus is irrigated and loosely packed with iodoform gauze. The packing is removed in

[51]Lamorier. Quoted by Hajek. *Nebenhöhlen der Nase*, 1903, p. 115.
[50]Roe. Methods of Opening the Maxillary Antrum with Presentation of a New Instrument. *Annals Otol., Rhin. & Laryn.*, June, 1909, p. 415.
[52]Küster. Ueber die Grundsätze der Behandlung von Eiterungen in Starrwandingen Höhlen. *Deutsche Med. Wochenschrift*, 1889, p. 233.

a few days and a gauze drain substituted. The flap closes the opening rapidly, only the use of the gauze drain preventing complete closure.

Hajek[53] describes a modified Küster operation. The patient is placed in a half-reclining position with the side to be operated uppermost. The upper lip is retracted and an incision made along the labiogingival fold, through mucosa and periosteum and the wound edges retracted. The bony wall is next removed with the electric trephine or with chisels. Usually there is very little bleeding which may be arrested by compression or by crushing the small vessels with artery forceps. After sufficient bone has been removed to expose the interior of the cell, it is irrigated with 1-5,000 bichloride of mercury solution. The lining membrane may now be examined and diseased areas removed, the bone wound being enlarged with bone forceps as required. The cell is now packed with iodoform or xeroform gauze, the ends of which are allowed to project through the wound.

The gauze is carefully removed in four or five days and renewed as the drainage demands for about two weeks, until the wound margins heal by granulation. A hollow prothesis is now inserted to maintain the opening and ventilate the sinus. The after-treatment is carried out by means of large specula similar to ear specula, but having a diameter of 6 mm. to 1 cm. Granulations, hypertrophies, etc., may be removed through the speculum by means of curettes, small punch forceps or snare under illumination from a head mirror or electric headlight. A headlight such as the Klaar (Fig. 920) is also very useful during the operation.

Claus[54] in operating for chronic maxillary sinuitis removes the anterior sinus wall completely with chisels and Hajek's bone-forceps which have the advantage of throwing the bone fragments outward. All diseased tissue is systematically removed from the interior of the cell and gauze tampons, usually saturated with protargol, are continued until the sinus is obliterated.

Hajek[55] describes his technic for performing the radical antrum operation of Luc-Caldwell. General anesthesia is necessary. The incision follows the line of attachment of the mucous membrane of the lip of the facial wall and extends from the canine to the second molar tooth. The mucoperiosteum is detached upward and held out of the field with retractors. The facial wall of the antrum is next chiseled away practically in its entirety and the antrum swabbed dry and in-

[53]Hajek. *Nebenhöhlen der Nase*, 1903.

[54]Boenninghaus. Die Resection der facialen und der nasalen Wand der Kieferhöhle, mit Einstülpung von Nasenschleimhaut in die letzere, zur Heilung hartnäckigen Kieferempyeme. *Archiv f. Laryng.*, Bd. VI, 1897, p. 213.

[54]Claus. Zur radikalen Operation der chronisch erkrankten Oberkieferhöhle. *Archiv f. Laryngol.*, 1904, Vol. XVI, p. 102.

[55]Hajek, *Nebenhöhlen der Nase*, 1903, p. 121.

spected by artificial light. All diseased areas are removed with curettes and cutting forceps. The best drainage is obtained by removing the nasal wall as low down as possible. The bony wall of the inferior meatus is removed carefully with a flat chisel, leaving the nasal mucous membrane intact. The wall is removed over an area at least 3 cm. long and upward to the attachment of the inferior turbinal. A probe passed into the inferior meatus at its roof from the nasal side is now used to press the membranous inferior meatal wall into the antrum, where it is cut through longitudinally the length of the bone wound. The flap is now incised at either end and used to cover the antrum floor. If the inferior turbinal be hypertrophied, it may be necessary to remove a portion of it to give better access to the interior of the antrum. This may be done from the antrum by cutting horizontally

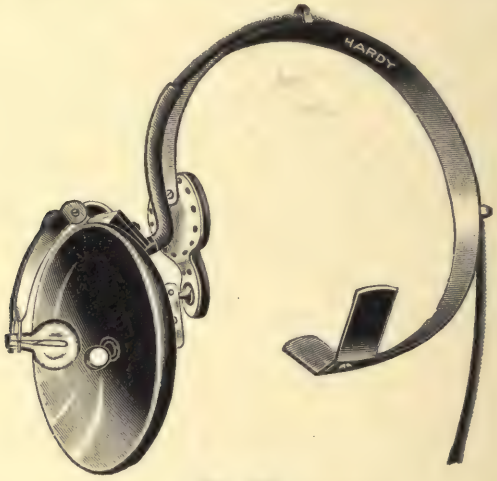


Fig. 920.
Klaar Electric Headlight.

through the thin bone just above the inferior turbinal attachment and with the inferior turbinal held with strong forceps, a section may be removed by cutting through the turbinal anteriorly and then posteriorly to the forceps. The sinus is now packed loosely with moist iodoform gauze and the end of the packing left in the nasal opening. The mucoperiosteum of the cheek is now sutured into position. The gauze is left in situ 10 days or two weeks if conditions are favorable and no severe pain or temperature results. Powdered iodoform may, after the removal of the gauze, be blown into the antrum through the nasal opening a few times.

Hajek believes that irrigation is to be avoided as it increases secretion and produces irritation of the fresh granulations. It often requires six months to one year for complete cicatrization to take place,

but if the after-treatment is not too vigorous this process goes on without annoyance to the patient.

The Denker Operation.[56]

This is the most radical method yet devised for operating on the maxillary sinus. It is indicated in those obstinate chronic cases where the more conservative measures have failed. The greatest advantage of this operation is the exposure of the anterior angle of the sinus next the nose, which is usually the seat of pathologic lesions and which other methods of operating fail to reach.

Under general anesthesia the patient is placed on his back with the head hanging downward over the end of the table, the Rose position. The throat is protected by postnasal tampons. An incision is made along the labiogingival juncture from the second molar to the median line and the periosteum with the overlying soft tissues elevated over the canine fossa. The anterior wall of the antrum is now removed with chisel and bone forceps as in the previously described methods. Next, the thick bridge of bone between the usual canine fossa opening and the apertura pyriformis of the nose is removed, exposing the anterior inner angle of the antrum. The interior of the cell is now inspected and pathological tissue removed with the curette. A flap is now made by elevating the mucoperiosteum of the inferior meatus and of the inferior turbinal. The nasal wall of the antrum, together with the anterior third of the inferior turbinal, is removed with bone forceps. A large opening is made to insure perfect ventilation and drainage and the previously described flap is turned down upon the antral floor and retained in position with a loose gauze packing for about two days. The after-treatment consists in cleansing the cell with physiological saline irrigations, drying it with compressed air and cauterizing exuberant granulations.

The Sturmann Operation.

Sturmann[57] reports his latest observations on his method of intranasal removal of the naso-antral wall. The success of Denker's radical operation which combined the good points of all previous operations led to his effort to perfect a less radical procedure which would give equally good results. The important point is the removal of the nasal wall well forward, uncovering the most anterior portion of the antrum and thus obtaining space for perfect ventilation and inspection of the entire cavity.

---

[56]Denker. Zur Radikaloperation des chronischen Kieferhöhlenempyems. *Frankel's Archiv f. Laryngol.*, Vol. XVII, p. 221.

[57]Sturmann. Erfahrungen mit meiner intranasalen Freilegung der Oberkieferhöhle. *Archiv f. Laryn.*, Vol. XXIII, p. 143.

The Robertson Operation on the Maxillary Sinus.

To avoid the loss of turbinal tissue and maintain a large communication between the antrum and the nose, Robertson[58] has devised a flap operation. An incision is made as usual from the second incisor along the labiogingival juncture as far backward as necessary. The soft

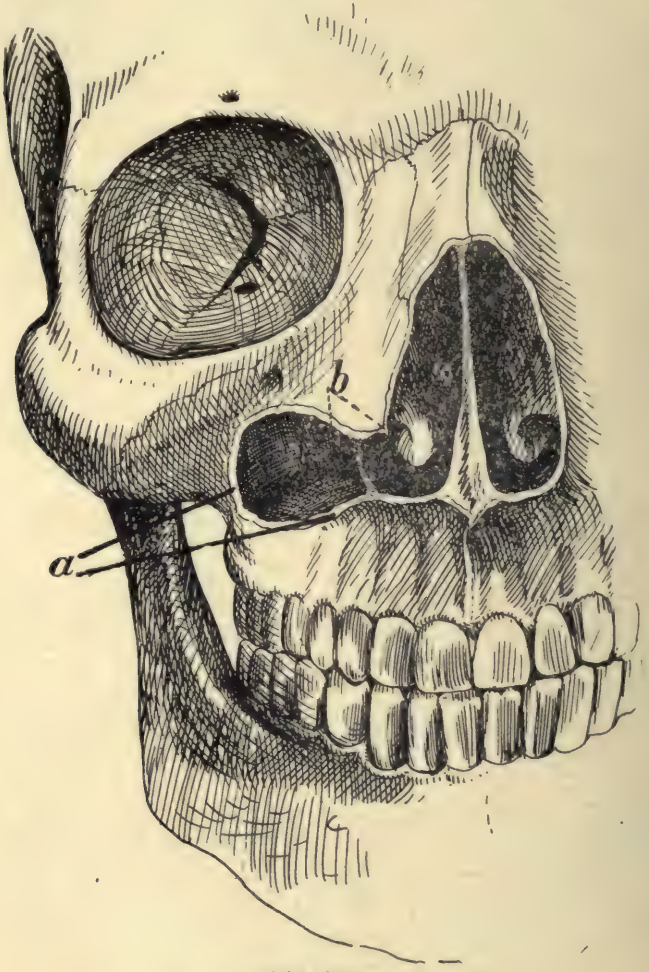


Fig. 921.

The Denker Radical Operation upon the Maxillary Sinus. *a*, Portion of Facial Wall of the Antrum which is removed in the Küster and Caldwell-Luc Operations; *b*, Additional Portion removed by the Denker Operation.

tissues of the facial wall are elevated as high as the infraorbital foramen and well over toward the nose. A large opening is made in the

[58]Robertson. New Flap in the Radical Operation on the Accessory Sinuses. *Chicago Medical Recorder*, Feb., 1909.

anterior antral wall and pathological tissue and bony septa removed. Next, the ethmoidal cells are curetted with a narrow, sharp, steel curette, avoiding the spheno-maxillary fossa immediately posterior to the antrum, the cranial cavity above, the orbit externally and the nasal cavity internally.

When the ethmoidal cells have been removed for a distance of five and one-half to six cm. the sphenoidal sinus is reached and may be opened, and when necessary, curetted. Robertson lays special stress

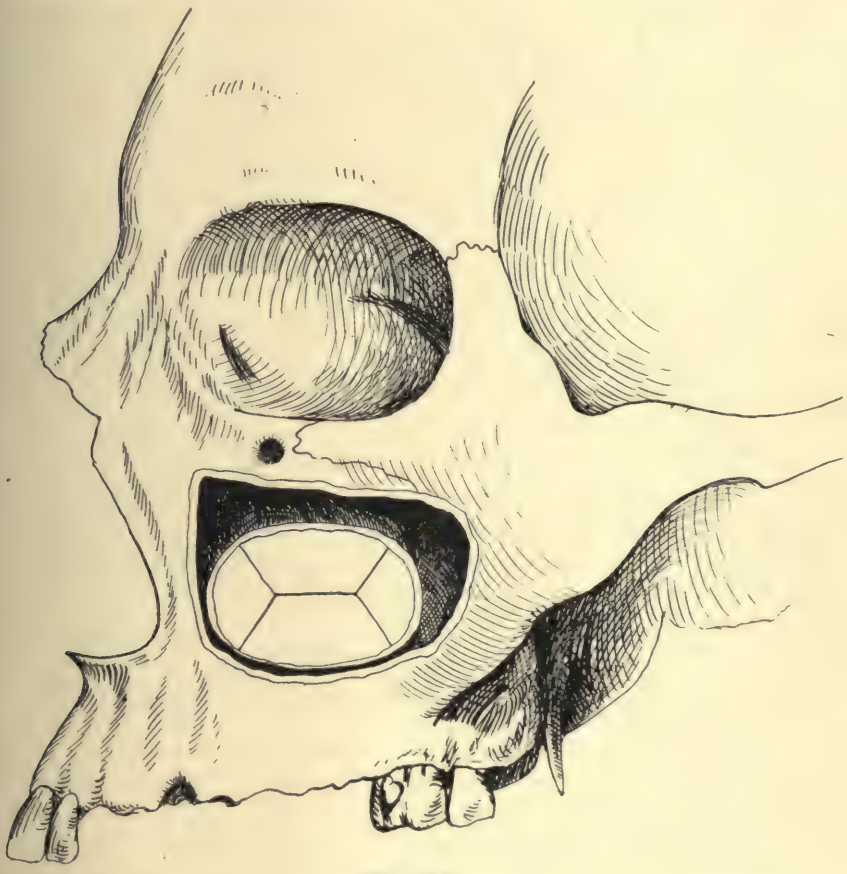


Fig. 922.

Illustrating Robertson's Method of Cutting the Flap of Nasal Mucous Membrane in the Radical Operation Upon the Antrum of Highmore.

on smoothing off the ridges along the floor of the ethmoid labyrinth to facilitate drainage into the antrum.

"The advantages of this operation over the old form are: 1. The cavity is rendered inoffensive on account of all the cells being destroyed. 2. The turbinals are not cut or injured, allowing the patient all the

physiological function of these tissues. 3. The opening is permanent after three or more years, as has been demonstrated by the author. 4. The recurrence of empyema is rendered nil, because the cavity has ample and permanent drainage. 5. The absence of prolonged after-treatment."

INTRANASAL OPERATIONS ON THE NASOLACHRYMAL DUCT.

Reference may be made at this point to the intranasal operation upon the lachrymal duct from its close relation to the antrum of Highmore. The various methods previously used in a few instances have consisted in resecting the anterior portion of the inferior turbinal and then cutting away the nasal wall of the duct. This has meant the loss of functionating tissue.

West[59] has devised an intranasal method of opening the lachrymonasal duct which he considers superior to former methods which required the partial resection of the inferior turbinal. A No. 4 probe is passed through the dilated punctum as a guide and then by means of small bevel-edged chisels, a portion of the lachrymal bone and superior maxilla is removed just above the inferior turbinal, forming a large opening in the duct. It is necessary to use care to avoid opening the maxillary sinus. Local anesthesia is used. Strictures below the window opening are unimportant as tears will drain through the window, while any stenosis high up in the duct is removed by the operation. The report is a preliminary one and details are lacking regarding the future of such cases. The work was done in association with Robert L. Randolph, who thinks highly of the method. It would seem that such a method gives promise of reaching the point of stenosis directly and of retaining the integrity of the delicate lachrymal apparatus.

AFTER-TREATMENT OF ANTRUM OPERATIONS.

The after-treatment of antrum operations is so important as to permit of some repetition here. Irrigation of the antrum through the artificial nasal opening, or through the Hajek prothesis, with warm physiological saline solution produces no irritation and is the best solvent for the secretions. For office treatments the author's irrigating apparatus is the ideal method. For home treatment the simple rubber bulb syringe (Fig. 924) with two valves is probably the most efficient. The nasal opening is so large that the patient easily learns to pass a curved canula into the antrum and do his own cleansing. Where the secretion is excessive one or two quarts of the solution may be used in

[59] West. A Window Resection of the Nasal Duct in Cases of Stenosis. *Trans. Amer. Ophthal. Soc.*, 1910, p. 654.

a fountain syringe as frequently as needed to prevent accumulation of pus. The frequency of the irrigation depends upon the amount and character of the secretion. As the secretion lessens or assumes a more mucoid appearance and consistency with fewer pus cells, the treatment may be gradually lessened in frequency, but should not be at once discontinued upon the cessation of discharge, irrigations being continued two or three times weekly for several weeks longer.

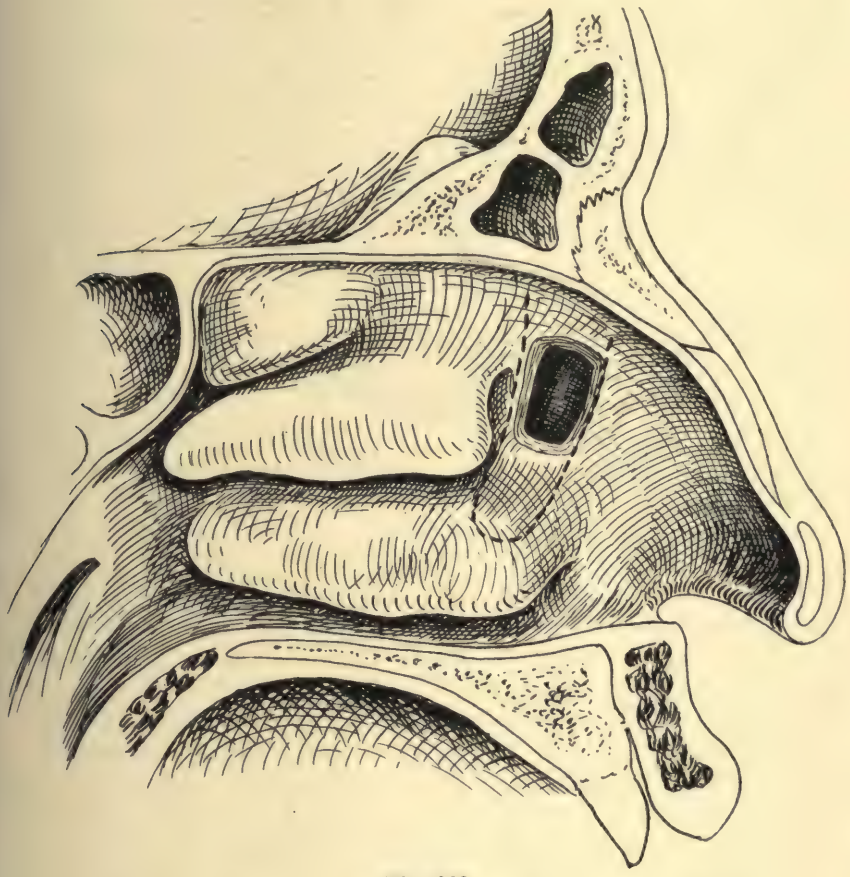


Fig. 923.
Intranasal Window Resection of Nasal Duct. (After West.)

Great care should be observed in rendering the patient resistant to reinfection from "colds" by attention to diet, exercise, fresh air and adequate elimination. Regular inspection of these cases before and after the office irrigations will often enable one to detect secretion in locations characteristic of infection of other sinuses, particularly the ethmoid. Here the author's suction apparatus is invaluable, bringing

forth secretion at the time of examination which otherwise could be only accidentally discovered. All hypertrophies, granulations, etc., should be cut away and the actual cautery or a chemical cautery such as trichloracetic acid applied to their bases.

Most of the acute antrum empyemas heal spontaneously, but where the secretion continues for several weeks, or when there is pain and tenderness over the antrum and the second bicuspid and first molar teeth, or reflex pain along the branches of the fifth nerve with pressure sensations on stooping, the cell should be emptied by the suction apparatus, irrigation through the natural opening or by puncture with a trocar and irrigation with physiological saline solution and 10 per cent. argyrol or similar non-irritating antiseptic injected.

The bacterial findings are often an indication for more radical measures or more frequent, persistent treatment as in cases where pneumococci, streptococci or influenza bacilli are found. In general

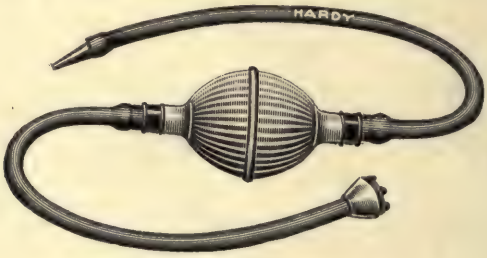


Fig. 924.
Double-valved Syringe.

when the suppuration continues for three or four weeks with no change in the character of the secretion toward a mucoid consistency, better drainage is indicated. The operation chosen should be one which may be performed under local anesthesia, such as the resection of a portion of the inferior turbinal and the antral wall of the inferior meatus intranasally. A small trephine opening in the fossa canina in cases where the patient for any reason cannot afford the time for treatment, allows of his carrying out the irrigation at home more easily perhaps than with an intranasal opening, although from its position it does not give the constant drainage which occurs with an opening near the nasal floor in the inferior meatus.

The process may be termed chronic when it continues for a period of two or three months. These cases even where the process has continued for several years may be cured by the irrigation treatment which should always be tried, especially in nervous patients who will do anything to avoid operative measures. The more radical methods, such as the Caldwell-Luc, are indicated only in the cases of long duration, or where the conservative measures have failed.

SURGICAL ANATOMY OF THE ETHMOID LABYRINTH.

The ethmoid bone is made up of a vertical plate, which forms the upper part of the bony nasal septum, the horizontal cribriform plate and the two lateral masses of cells. These masses are made up of irregularly shaped air cells lying between the nose and the orbit, the external lateral surface, the lamina papyracea forming part of the inner orbital wall.

The cell mass is roughly partitioned by the so-called basal lamellæ of Seydel[60] who described five. The first forms the uncinate process, the second the bulla of the ethmoid, the third and fourth the middle and superior turbinate bodies and occasionally a fifth is found bearing a still higher turbinate body. These lamellæ extend through the mass of cells to the os planum and up to the cribriform plate and are roughly divided by the middle turbinal and its lamella into an anterior and a posterior group. This division is also a clinical one as secretion from the anterior group drains into the middle meatus, the space underneath the middle turbinal, and secretion from the posterior group drains downward and backward over the middle turbinal.

According to Logan Turner,[61] the superior boundary of the ethmoid labyrinth is the ethmoid edge of the orbital plate of the frontal bone with its depressions or foveae. Inferiorly the ethmoidal margin of the orbital plate of the superior maxilla is the boundary line. Anteriorly the boundary is the lachrymal bone and the nasal process of the superior maxilla. Thus it is apparent that the ethmoidal labyrinth is in the closest relationship to the entire inner orbital wall, while posteriorly the ethmoid bone articulates with the sphenoid and in this region maintains a fairly constant relation to the optic nerve. The anterior group of ethmoidal cells except in extremely rare instances, has no relation to the optic nerve. On the contrary the posterior ethmoidal cells, especially at the postero-external angle, are almost always found to border on the optic canal. The relation of the last cell of the posterior ethmoid group to the optic nerve was first demonstrated by Onodi[62] and his findings have recently been confirmed by Loeb and others who show that the sphenoidal sinus may be entirely replaced by this cell.

Loeb's[63] measurements of the ethmoidal labyrinth show a variation in the antero-posterior diameter of 22 to 54 mm., supero-inferior

---

[60] Seydel. *Ueber Nasenhöhle Säugetiere u. Menchen. Morphol. Jahrb.*, Leipzig, 1891.

[61] Logan Turner. *The Accessory Sinuses of the Nose*, 1902.

[62] Onodi. The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope*, Nov., 1909, and the Optic Nerve and Accessory Sinuses of the Nose, Lückhoff's Translation, 1909.

[63] Loeb. A Study of the Anatomic Relations of the Optic Nerve to the Accessory Cavities of the Nose. *Annals of Otol. & Rhin.*, June, 1909.

17 to 59 mm. and lateral 9 to 28 mm. Onodi[64] gives the average width of the anterior ethmoidal cells as 10 to 29 mm. The posterior cells extend into the area of the sphenoid bone and may vary from 8 to 40 mm. in width. They frequently extend upward forming part of the superior orbital wall and the wall of the canalis opticus. In their extension backward they frequently reach the sella turcica and the fissura orbitalis superior and the foramen rotundum.

Onodi described also what he terms a semicanalis ethmoidalis which is a membranous canal containing a group of veins and extend-

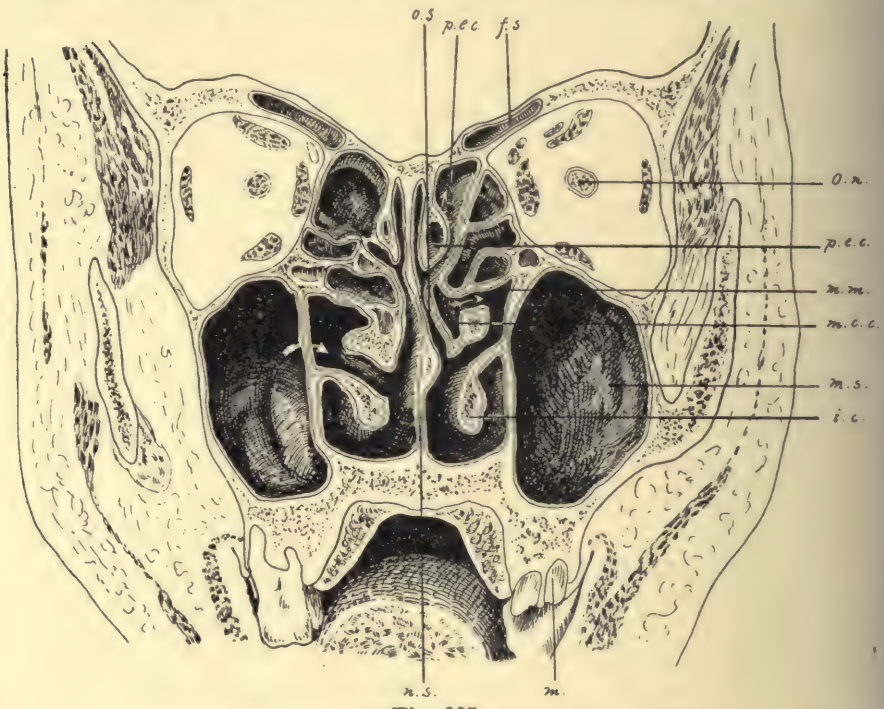


Fig. 925.

Relation of the Ethmoidal Cells and Nasal Accessory Sinuses to the Orbit. *o, s,* Olfactory Sulcus; *p, e, c,* Posterior Ethmoidal Cells; *f, s,* Frontal Sinus; *o, n,* Optic Nerve; *m, m,* Middle Meatus; *m, c, c,* Cell in Middle Turbinal; *m, s,* Maxillary Sinus; *i, c,* Inferior Turbinal; *m,* Molar Tooth; *n, s,* Nasal Septum.

ing from the anterior ethmoidal foramen along the wall of the frontal sinus or anterior orbital cells to the anterior cranial fossa.

Diagnosis of Ethmoid Diseases.

The detection of disease processes in the ethmoid labyrinth is perhaps the most difficult accessory sinus diagnosis which we are called

[64]Onodi. The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope*, Nov., 1909.

upon to make. The tendency of infections in these cells is to run a latent course and they are so frequently diseased simultaneously with the other accessory sinuses that it is difficult to determine which symptoms of those present as to be referred to the ethmoid cells.

The *pain* of an acute ethmoiditis or of an exacerbation of a chronic process is usually found at the root of the nose, although there is no typical headache or localization of pain in these cases. Disturbance of the sense of smell is frequently present, especially where secretion from the posterior ethmoidal cells fills the olfactory fissure. Many times the first symptoms are those of nasal stenosis, due to polypi formation.

The *objective examination* of these cases reveals pus in the middle or superior meatus with a tendency to crust formation. Various degrees of hypertrophy of the turbinal tissues may be present, varying from flat circumscribed elevations to masses of polypi. Bare bone may be detected with the probe in the ethmoidal region, although one must not forget that the manipulations may have injured the delicate membrane overlying the cells.

As a rule infection occurs in one cell, chiefly the bulla ethmoidalis or in several neighboring cells, the entire labyrinth rarely being involved. The anterior cells are more frequently infected than those posterior to the middle turbinal, their position exposing them to secondary infection from diseased frontal sinuses and antra.

The anterior ethmoidal cells when infected may cause disease of the lachrymal sac or simulate it by perforation and a resulting abscess around the sac. An orbital abscess pointing low occasionally produces the same appearance. *Differential diagnosis* is unusually difficult but may be rendered certain by irrigating the sac through to the nose or locating ethmoidal disease in the nose and draining the cells.

From their location, occupying almost the entire inner orbital walls, *the ethmoidal cells are the most frequent source of orbital infection and probably act equally with the sphenoidal sinus as the source of optic nerve disease.* The internal recti muscles lying as they do, contiguous to the inner orbital wall, are frequently involved in ethmoidal cell disease, presenting the muscle picture of insufficient converging power and lowered adduction with subjective symptoms of muscular asthenopia.

Pus originating in the posterior ethmoidal cells presents above the middle turbinal or is seen by posterior rhinoscopy in the choana. When seen in the latter position the pus may indicate either sphenoidal or ethmoidal disease or both and it may be impossible to differentiate except by irrigating the sphenoidal sinus. Pus and crusts covering the vault of the pharynx practically always mean sphenoidal or posterior ethmoidal disease. Occasionally where the middle turbinal closes the mid-

dle meatus anteriorly, secretion from the anterior group of sinuses may drain backward simulating disease in the posterior cells or the secretion may be drawn backward by the patient in "hawking."

There are two types of ethmoidal infection, the open and the closed empyemas, the first type frequently passing into the second. In the first type pus is found draining into the nose while in the other it remains shut up within the cells, where it may cause them to dilate, forcing the lamina papyracea outward into the orbit producing proptosis of the eyeball and disturbances of the ocular muscles. Where the dilatation is bilateral the so-called "frog-face" results. When the dilatation takes place toward the nose it is seen filling the middle meatus or as a cystic middle turbinal. The appearance is that of a large polypus until a probe reveals the bony consistency of the wall.

Where the secretion flows over the turbinals and forms crusts, atrophy results. The secretion which produces ozæna or rhinitis atrophicans foetida undoubtedly originates from the mucous membrane covering the ethmoidal labyrinth according to Hajek.[65]

Where inspection of the middle meatus is rendered difficult or impossible by the position of the middle turbinal, the latter may be bent away from the lateral nasal wall until its attachment fractures. This is easily accomplished by Killian's long nasal speculum which is introduced into the middle meatus and the blades forcibly separated. A small tampon is left in the middle meatus a few days until the fracture has healed sufficiently to retain the turbinal in its new position. In the opposite condition where the middle turbinal produces pressure against the septum with reflex ocular symptoms the Killian speculum is introduced between the septum and the turbinal and the latter fractured and forced outward against the lateral nasal wall, avoiding a turbinectomy and conserving functionating tissue.

SURGICAL TREATMENT OF ETHMOIDAL DISEASE.

Drainage of the cells of the ethmoidal labyrinth may be accomplished intranasally or by one of the external methods. Where polypi and hypertrophies are found in the nose interfering with the drainage they should be thoroughly removed with snare, punch forceps or curettes. In some cases this will prove sufficient, especially if supplemented by some form of suction treatment applied for an hour daily. The galvano-cautery is a dangerous procedure in this condition, owing to the excessive and long-continued reaction it produces and should be avoided.

The *intranasal route* to the ethmoidal cells is indicated in all ex-

[65] Hajek. *Nebenhöhlen der Nase*, 1903, p. 226.

cept the most severe types of acute infection with signs of orbital or cranial involvement and in chronic cases complicated by disease of the adjacent sinuses. While in many cases it will be found impossible to remove all of the diseased ethmoidal cells intranasally, yet the patient prefers to endure the excess nasal secretion rather than have an external operation. The chance of a disfiguring scar, especially in young girls, outweighs the advantages of the more thorough surgical procedure. These cases may then be considered satisfactory when they are relieved of pain, recurrences and excessive nasal discharge and are safe from possible involvement of the neighboring ocular structures or the cranial cavity.

The first step necessary to reach the ethmoidal cells is the removal

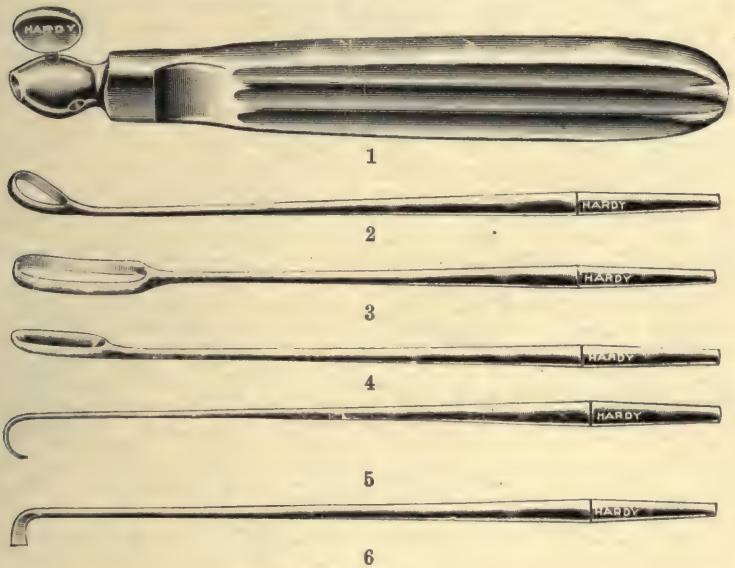


Fig. 926.
Ethmoidal Instruments.

1. Universal Handle.
2. Coakley's Antrum Curette, long curve.
3. Fenestrated Curette, sharp and long.
4. Curette.
5. Sharp Hook.
6. Hajek's Knife.

of a portion of the middle turbinal. The middle meatus is thus exposed and many times the location of secretion, crusts or flat hypertrophies will indicate the diseased cells. These cells may now be entered with one of Hajek's hooks or curettes (Fig. 926) or the Sluder knife (Fig. 885) and a portion of the wall cut or broken away. The removal of the wall may then be completed by some form of punch forceps such as the Myles or Grünwald forceps (Fig. 888).

It may be necessary to do the operation in several sittings as the field is likely to be obscured by hemorrhage, interfering with the thorough removal of diseased tissue.

Ballenger's Operation for Removal of the Ethmoid Cells.

Ballenger[66] in 1905 devised a method for removing the ethmoidal cells and middle turbinal en masse. Owing to the fact that the ethmoidal cells have only three planes of attachment Ballenger found it possible to remove a large part of the posterior ethmoidal cells and some of the anterior cells with the middle turbinal in one piece. The chief instrument used consists of a long blade, curved slightly on the flat, and having a shorter blade attached at right angles to the end of the first blade (Fig. 927).

After inducing anathesia with powdered cocain the ethmoid

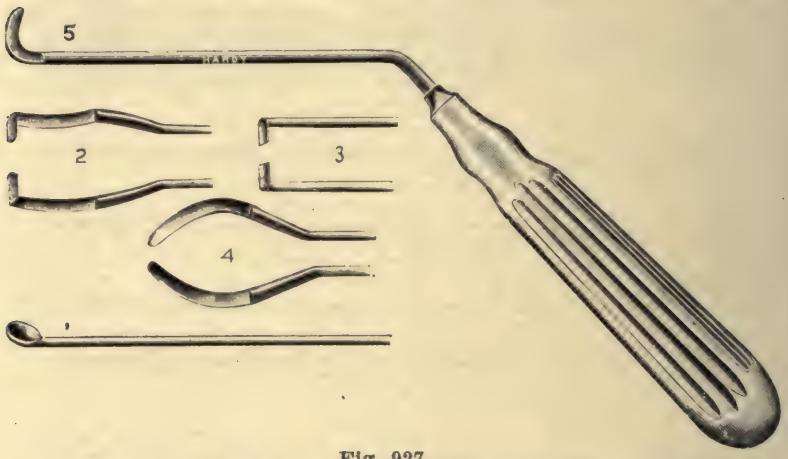


Fig. 927.
Ballenger's Set of Ethmo-Turbinal Knives and Sphenoid Curette.

knife is introduced into the nose with the short blade upward and passed backward through the middle meatus to the anterior sphenoidal wall, or until it engages the posterior end of the middle turbinal. The handle of the knife is turned horizontally across the opposite side of the face during this step of the operation. The short blade is now forced outward with a to and fro motion through the attachment of the ethmoid cells to the anterior wall of the sphenoidal sinus. The handle of the instrument is then rotated downward forty-five degrees until it lies directly in line with the nose. The short blade is then forced upward to the cranial plate, the long blade being in the middle meatus. Next, the blades are made to cut forward by rotating them back and forth in their axes, fracturing the ethmoidal cell walls and

[66]Ballenger. *Diseases of the Nose, Throat and Ear*, 1909, p. 233.

then cutting through the lining membrane. When the anterior attachment of the middle turbinal has been reached the knife handle is rotated upward almost to a horizontal position across the same side of the face, and the knife drawn forward and downward to complete the incision. The mass may now be removed with the dressing forceps, the wound sponged dry and any remaining fragments of the cell walls removed with a curette.

Where the bleeding is excessive the region of the wound may be packed with a strip of gauze one and one-half inches wide impreg-

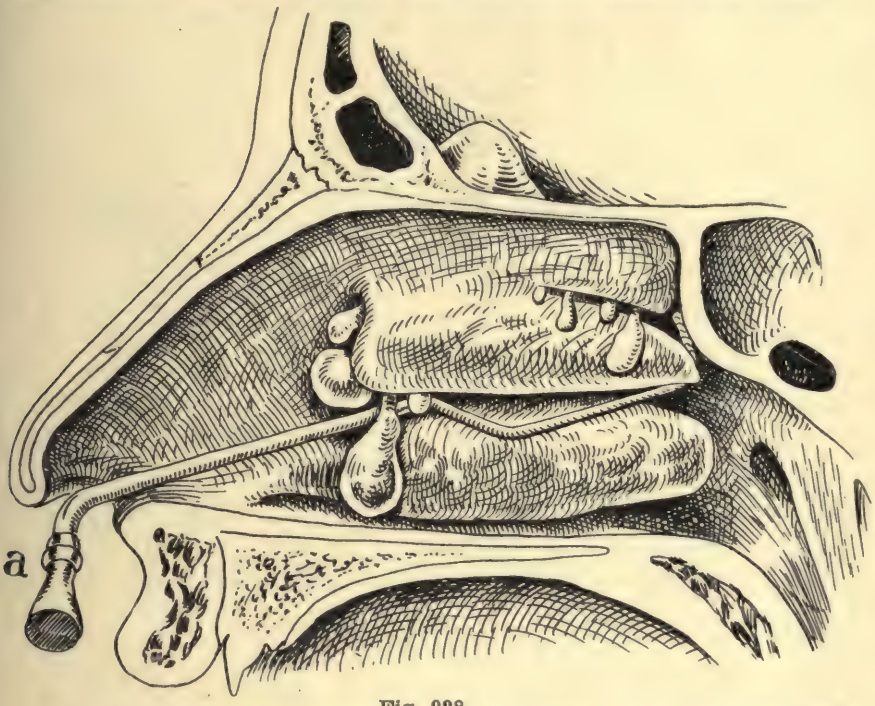


Fig. 928.

First Step of Ballenger Operation for the Removal of the Ethmoidal Cells with the middle Turbinal. The Ethmo-Turbinal Knife is shown in position at *a*.

nated with bismuth subnitrate powder. The gauze may usually be removed in twenty-four hours and the wound treated daily with tampons of cotton saturated with a ten per cent. aqueous solution of ichthyol or argyrol left in place twenty minutes. Ballenger finds this method of after-treatment superior to irrigations. He rarely packs the nose except for severe hemorrhage. If the patient is operated upon in the hospital and immediately put to bed the danger of hemorrhage is not great and packing may be dispensed with. The patient should be warned not to blow his nose as air may be forced into the orbital

tissues and if sneezing occurs the force of the sneeze should be lessened by "sneezing through the open mouth." Secretions may be gently aspirated backward into the throat.

Ballenger has never observed orbital infection following operations upon the ethmoid in an experience covering over four hundred operations. He has never seen meningitis follow as the cribriform plate of the ethmoid and the cranial plate of the frontal bone are not easily fractured.

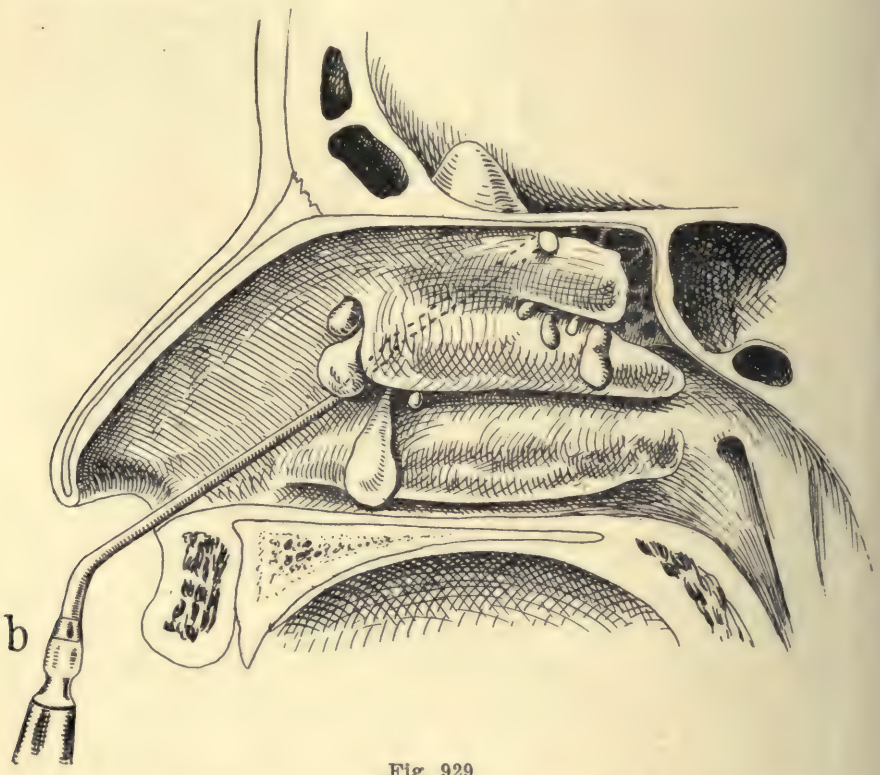


Fig. 929.

Second step in the Ballenger Ethmoid Operation. The position of the Knife as it cuts forward is shown at *b*.

EXTERNAL OPERATIONS UPON THE ETHMOIDAL CELLS.

Hajek[67] concludes after an extensive experience that it is almost impossible to bring about an ideal result with entire cessation of secretion by means of the endonasal methods of operating upon the ethmoidal cells. He has usually found that in spite of painstaking removal of cell after cell with the lining membrane, the secretion has persisted. In the more severe types of ethmoidal diseases Hajek

[67] Hajek. *Nebenhöhlen der Nase*, 1903, p. 251.

follows the method of Kuhnt which he quotes in full. The skin incision begins at the upper border of the internal palpebral ligament and is carried upward to the supraorbital margin. The periosteum is then carefully elevated conserving the trochlea. Hajek continues the incision downward carefully raising the lachrymal sac from its position, thus gaining sufficient space to easily reach the ethmoidal cells.

Other methods of operating upon the ethmoidal cells have been dealt with as a part of the various operative procedures upon the frontal and maxillary sinuses. The external route is absolutely indicated where orbital cellulitis or abscess exists or where intranasal procedures have failed.

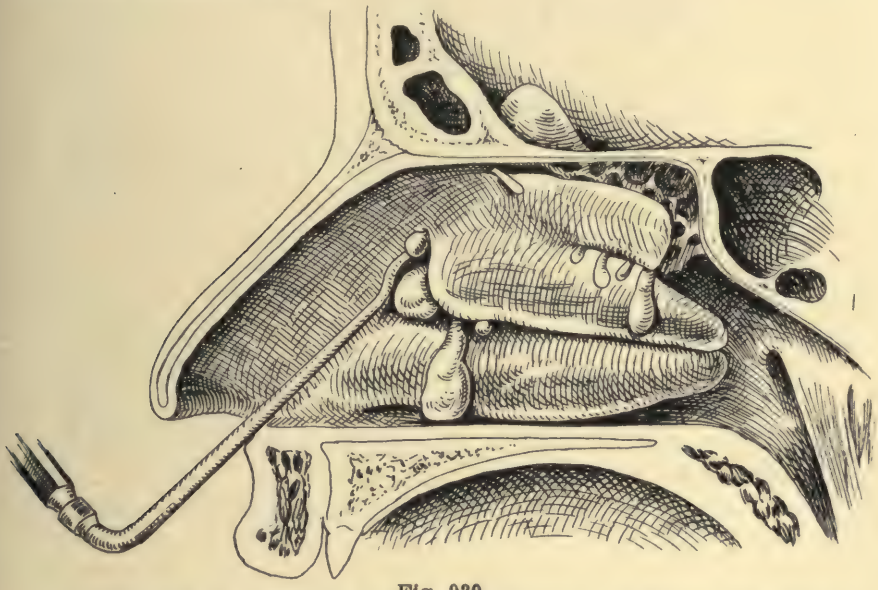


Fig. 930.

Final Step in Ballenger's Ethmoid Operation. As Shown, the Knife is Turned to cut out at the Anterior Attachment of the Middle Turbinal.

SURGICAL ANATOMY OF THE SPHENOIDAL SINUS.

The two sphenoidal sinuses occupy the central portion of the sphenoid bone. A bony septum separates the two air spaces and extends beyond the plane of their anterior walls where it is known as the rostrum of the sphenoid. This rostrum joins the perpendicular plate of the ethmoid to form the supero-posterior portion of the nasal septum. Occasionally the septum between the cells is absent, making one large sphenoidal sinus or it may develop obliquely producing assymetry in the size of the cells.

The sphenoidal sinus has six walls. The superior wall presents toward the cranial cavity, carrying on either side the foramen opticum

and farther back the sella turcica. On this wall lie the optic chiasm and the hypophysis cerebri. This upper wall is usually thin, the prominences of the foramen opticum and sella turcica or the canal of the internal carotid artery sometimes being found to project into the sinus. The lateral wall also borders the cranial cavity and is partly formed by the bony canal which supports the internal carotid artery and the cavernous sinus. The lower wall forms part of the roof of the nose and of the nasopharynx and with the posterior wall forms the thickest of the sinus walls. Only exceptionally when the sinus is very large are these walls found to be thin. The anterior wall is the most important because it contains the ostium and in its upper portion it is the thinnest wall of the sinus and therefore the most approachable from a diagnostic and surgical standpoint. The ostium of the sphenoid usually lies above the middle line of the anterior sphenoid wall and opens into the recessus spheno-ethmoidalis formed by the attachment of the lateral mass of the ethmoid cells to the anterior surface of the sphenoid bone. The prominence of the middle turbinal prevents the ostium from being seen during a nasal examination, although this may be possible when the long Killian speculum is used to press the turbinal aside.

Loeb[68] found a great variation in the measurements of the thirty sphenoid sinuses studied. The antero-posterior diameter varied from 2 to 42 mm.; the supero-inferior from 4 to 38 mm. and the lateral from 2 to 35 mm. The smallest sphenoid sinus found measured 2x4x2 mm., the largest 42x22x34 mm.

Diagnosis of Sphenoidal Diseases.

The *chief subjective symptom of sphenoidal sinus disease is headache which is usually occipital, temporal or behind the eyeball; and the principal sign, postnasal discharge, draining downward into the nasopharynx.* Where the secretion is profuse the patient complains of the "dropping" of secretion into the pharynx or the formation of crusts on the pharyngeal vault. The location of the pain is, however, very inconstant and many cases never experience headaches.

Mental disturbances which are frequent in disease of all accessory sinuses are most pronounced in sphenoidal disease. The most prominent mental symptoms are lack of concentration, loss of memory, depression, hypochondriasis and neurasthenia.

Mild attacks of sphenoidal inflammation may occur with each attack of acute rhinitis until finally the process becomes chronic with almost constant secretion draining postnasally. It is frequently impossible to differentiate between infection of the posterior ethmoidal

[68]Loeb. A Study of the Anatomic Relations of the Optic Nerve to the Accessory Cavities of the Nose. *Annals of Otol. & Rhinol.*, June, 1909.

cells and that of the sphenoidal sinus and they are very often involved simultaneously. Objectively, secretion from an infected sphenoidal sinus may be seen by an anterior rhinoscopy flowing downward from the olfactory fissure or, as more frequently happens, with the aid of the postnasal mirror, it may be seen draining over the posterior end of the middle turbinal or forming a crust on the vault of the pharynx. Occasionally a long string of secretion may be seen adhering to the posterior border of the septum.

After removing all nasal secretion with irrigations of warm physiological saline solution and shrinking the turbinal tissue with cocain 4 per cent and suprarenalin 1-1000, fresh secretion may be seen draining downward into the choana. This is probably sphenoidal in

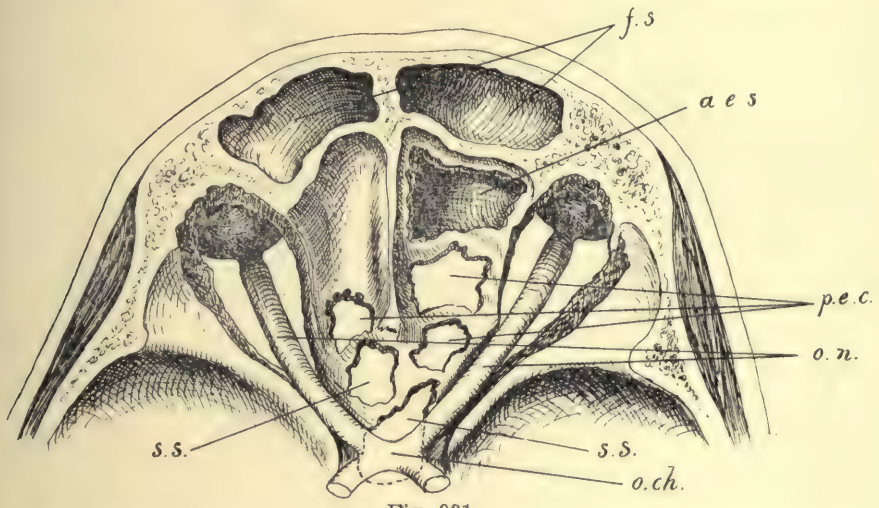


Fig. 931.

Relation of Optic Chiasm, Optic Nerves and Eyeball to the Nasal Accessory Sinuses. *f, s*, Frontal Sinus; *a, e, s*, Anterior Ethmoidal Cells; *p, e, c*, Posterior Ethmoidal Cells; *s, s*, Sphenoidal Sinus; *o, n*, Optic Nerve; *o, ch*, Optic Chiasm.

origin as very little secretion drains from the posterior ethmoidal cells after the patient has been in the erect position for a few hours. Bending the head forward to place the sphenoidal ostium at the lowest point of the cell facilitates the outflow of secretion. If the findings are negative the author now applies his suction apparatus (q. v.) for five minutes and re-examines the patient, when a string of fresh secretion may often be seen hanging downward over the end of the middle turbinal or against the septum posteriorly. The suction treatment may be applied several times if the first attempts are negative.

The middle turbinal may show hypertrophic changes due to the irritation from the sphenoidal secretion, but in uncomplicated cases

polypi are seldom seen. The olfactory fissure is frequently almost closed by the swelling of the middle turbinal, its location being marked by dried secretion which when wiped away reveals the thick pus which fills the fissure.

After cleansing and cocainizing the nose *it may be possible to reach the ostium of the sphenoidal sinus by means of a silver probe* curved slightly downward at the tip. The probe is held anteriorly

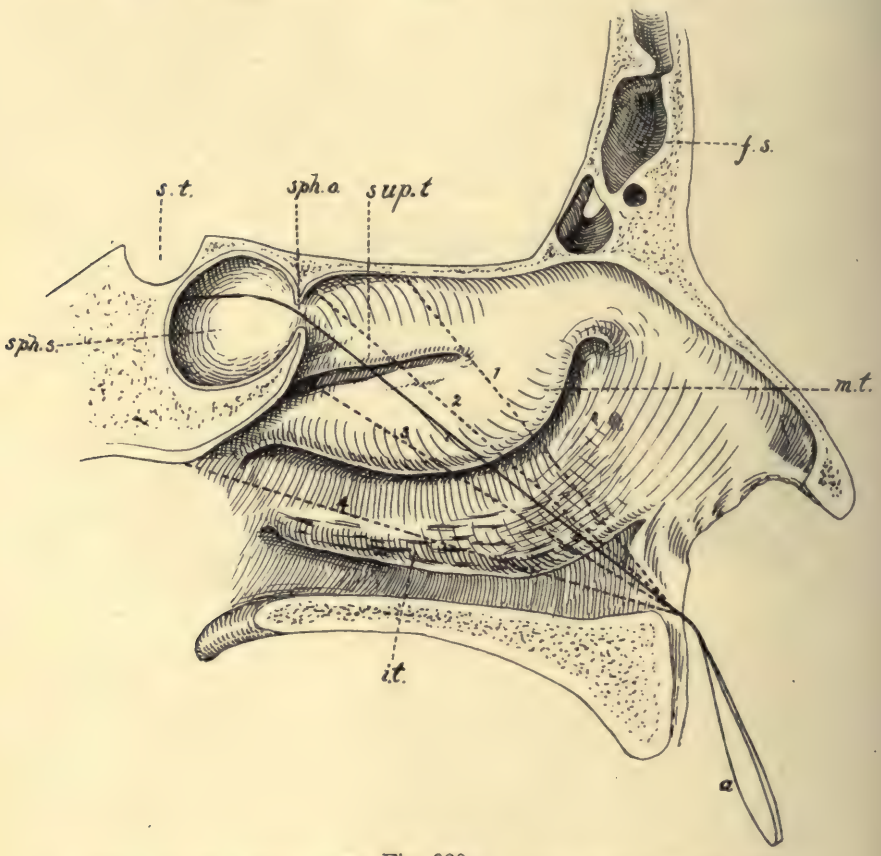


Fig. 932.

Probing of the Sphenoidal Sinus. Dotted Lines Show Possible Erroneous Directions of the Probe. Black Line Shows Correct Direction. *sph, s,* Sphenoidal Sinus; *s, t,* Sella Turcica; *sph, o,* Sphenoidal Ostium; *sup, t,* Superior Turbinal; *f, s,* Frontal Sinus; *m, t,* Middle Turbinal; *i, t,* Inferior Turbinal; *a,* Probe. (After Hajek.)

against the inferior nasal spine and passed between the septum and the middle turbinal crossing the latter at its middle. When it has passed into the nose 7 cm. it should reach the anterior sphenoidal wall in the neighborhood of the ostium. The distance varies in different

sized heads, but the direction of the probe is always in the same line which is known as the line of Zuckerkandl.[69]

The ostium lies usually in the upper half of the anterior wall and in many cases may be easily probed in the manner just described or by means of Andrews' curved sound (Fig. 933). Should the opening lie deep within the recessus spheno-ethmoidalis, however, it may be impossible to reach it without resecting the posterior portion of the middle turbinal and possibly one or more of the posterior ethmoidal cells also. When the tip of the probe has reached a point 7.5 to 8 cm. from the inferior nasal spine in small heads it is safe to say that it has entered the cell, but in larger heads the distance will vary from 8.5 to 10 cm. In some instances the anterior sphenoidal wall may be exposed by forcing the middle turbinal outward with the long Killian speculum.

When the ostium has been located and all secretion removed from the nose, a small coin-silver canula may be bent to the curve already

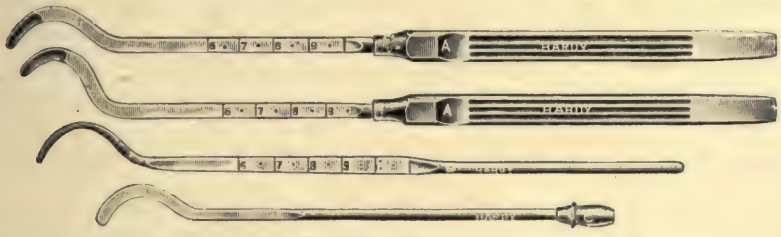


Fig. 933.

Set of Sphenoid Instruments. *a*, Knives; *b*, Probe; *c*, Cannula. (Andrews.)

found necessary for the probe and the cell irrigated with physiological saline solution to determine the presence of secretion.

Ocular Symptoms of Sphenoid Disease.

The *eye symptoms,* aside from orbital cellulitis or abscess with proptosis, are in great measure due to optic nerve involvement. The *optic nerve changes* at the disc in sphenoidal disease vary from a slight edema to an active papillitis, the latter is comparatively rare, however. The subjective symptoms are dimness of vision or absolute blindness in the affected eye and unilateral headache increased by stooping, by a heavy meal or by alcoholic drinks. The menstrual period is usually accompanied by an increase in the headache. *Vertigo and nausea* accompany the severe pain which tends to recur at relatively the same hour each day during the progress of the attack. The patient may be almost delirious with the pain and pressure headache —not relieved by drugs—or may lose his ability to concentrate his

[69]Zuckerkandl. *Normale u. Pathologische Anatomie der Nasenhöhle,* 1893.

mind on any one thing or to think clearly. The pain frequently occurs during the night as the recumbent position induces turgescence of the erectile turbinal tissue, especially in the lowermost side of the nose. Edema about the disc or between it and the macula is common and with it is usually noted dilation of the retinal veins. The vision is usually lowered in proportion to the extent of the optic nerve involvement and in cases where it is not appreciably lowered for the usual tests, the reduction of the illumination of the test types or the use of the Bjerrum test cards as suggested by Posey[70] will detect the difference between the two eyes.

Relative central and paracentral scotomata are frequently to be found, especially when a small red test object of 1 to 2 mm. in diameter is used. Other sources of possible toxic eye disturbance should always be excluded, such as alcohol and tobacco, syphilis and intestinal autointoxication.

New growths practically never produce optic nerve changes unless they break through the cell walls and involve the orbit. Hysteria and neurasthenia frequently manifested in sinus disease should be excluded as a cause of the lowered vision. Paresis of one or more of the ocular muscles has frequently been noted.

OPERATIVE TREATMENT OF SPHENOIDAL AFFECTIONS.

In some cases it will be possible to relieve the subjective symptoms and bring the secretion to an end by irrigations followed by drying the cell with compressed air and insufflating xeroform powder. Where this does not suffice it becomes necessary to enlarge the ostium. Hajek[71] has devised a number of sharp hooks and curettes (Fig. 926) for this purpose which fit a universal handle. The Sluder knife (Fig. 885) may also be used for this operation. The sharp hook or angle knife is passed into the ostium and pulled forward and downward through the sinus wall and then reintroduced and the wall cut through at each side of the opening. The fragments may now be removed with forceps and the wound enlarged with cutting forceps (Fig. 888) to any extent desired. Should the lining membrane appear red, edematous and discolored or granulations and polypi be present, they may be cautiously removed with a small curette. This procedure may well be postponed to a later sitting, however, as the increased drainage and after-treatment will frequently result in the return to normal of the greater part of the lining membrane.

The curetting of the sphenoidal sinus is not devoid of danger,

---

[70]Posey. The Ocular Symptoms of Affections of the Accessory Sinuses of the Nose. *Trans. Sec. of Ophthalmology, A. M. A.*, 1905.

[71]Hajek. *Nebenhöhlen der Nase*, 1903, p. 285.

the carotid artery lying free in the cell in ten per cent. of the cases and the thin bone walls offering but slight protection to the important surrounding structures.

The *after-treatment* consists of irrigations, applications of a 10 per cent. solution of argyrol or ichthyol, 1 per cent. silver nitrate or zinc chloride or insufflations of xeroform powder.

The endonasal operation suffices for all uncomplicated cases of sphenoidal disease, the more radical operations, by way of the frontal sinus, orbit and antrum of Highmore, being reserved for cases of combined empyema.

Curtis[72] was the first to operate on a case of sphenoidal abscess by enlarging the ostium with a long-shaft trephine after removal of the middle turbinal.

Hajek's Operation on the Sphenoid Sinus.

Hajek[73] has modified his sphenoidal sinus operation by the use of cutting forceps (punch) in addition to the various sharp hooks. The forceps are as strong as is possible in instruments which must be narrow enough to pass into the olfactory fissure. The forceps come in pairs, one with cutting jaws upward to remove the wall above the ostium and the other with jaws downward to remove the wall below the ostium. He finds that the average proportion of the pars nasalis of the anterior sphenoidal wall is 3 and the pars ethmoidalis 5, allowing plenty of room for intranasal operations. Hajek uses his set of hooks to remove the posterior ethmoidal cells, thus uncovering the entire anterior sphenoidal wall. Local or general anesthesia is used, both requiring adrenalin tampons in the olfactory fissure to insure as bloodless a field as possible. The hook with point down to avoid possible injury of the cribriform plate is passed upwards and backwards above the middle turbinal until it reaches the anterior sphenoidal wall, when the point is rotated outward cutting into the ethmoidal cells. By pressing the handle toward the septum the hook passes more deeply into the cells and by a strong pull is made to cut through them, taking with it a part of the attached middle turbinal. The fragments may then be removed by forceps.

Thorough *after-treatment* is necessary to prevent the great tendency to closure of the wound. The granulations are cauterized every 5-8 days, a small area being treated at each sitting to avoid reaction.

Killian[74] suggests that the sphenoid be reached by dilating the

---

[72]H. Holbrook Curtis. The Sphenoidal Sinus and Its Surgical Relationship. *Trans. Amer. Laryn., Rhin. & Otol. Soc.*, 1904, p. 103.

[73]Hajek. Zur Diagnose und intranasalen-chirurgischen Behandlung der Eiterungen der Keilbeinhöhle und des hinteren Siebbeinlabyrinthes. *Archiv f. Laryn.*, 1904, Bd. 16, p. 105.

[74]Killian. Verhandlungen der Deutschen Otologisch. Gesellschaft, Heidelberg, 1900.

middle meatus, opening the bulla of the ethmoid and thence to the posterior ethmoidal cells and anterior sphenoidal wall. Details of the actual operation are not given in this report. Hajek[75] finds that the sphenoidal wing contains a posterior ethmoidal cell in about 25 per cent. of the specimens examined by him. He detected disease in this cell when pus continued to flow downward into the nasopharynx after irrigation of the sphenoidal sinus and succeeded in passing a probe into its ostium. Berens[76] describes the so-called *antral route* to the sinuses performed by Jansen, Luc and Boenninghaus. It is a very elaborate performance for an account of which his paper should be consulted.

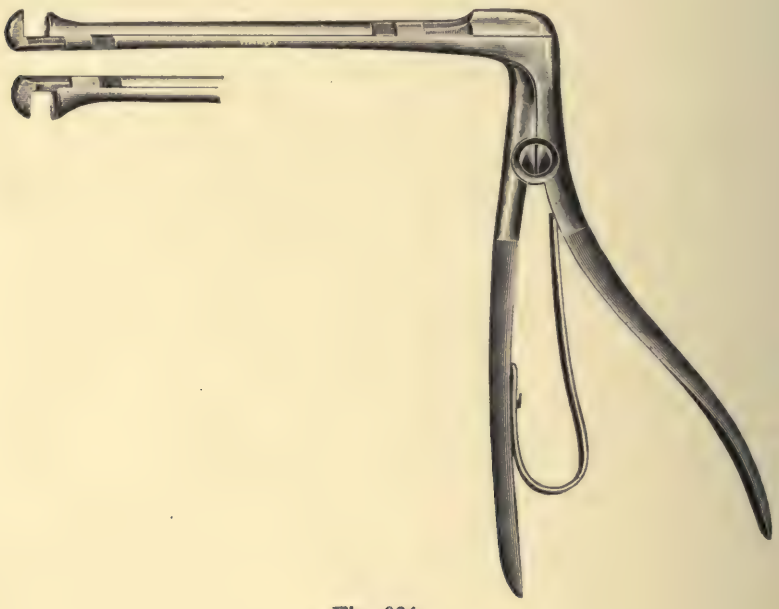


Fig. 934.
Hajek Sphenoid Punch.

Operations on the Cavernous Sinus.

Langworthy[77] reports several cases of thrombosis of the cavernous sinuses, secondary to mastoid infection, showing paralysis of external recti muscles, dilated pupils, exophthalmos and lid edema and, later, choked disc.

---

[75]Hajek. *Archiv f. Laryn.*, Vol. 16, 1904, p. 105.

[76]T. Passmore Berens. Fourteen Cases of Multiple Sinuitis Operated upon by the Maxillary Route. *Trans. Amer. Laryn., Rhin. & Otol. Soc.*, 1904.

[77]Langworthy. Thrombosis of the Cavernous Sinuses: Report of Four Cases. *Boston Med. & Surg. Jour., April*, 1907, p. 528; and A Proposed Operative Measure for Thrombosis of the Cavernous Sinus. *Laryngoscope, July*, 1906.

Hartley and Krause[78] reach the cavernous sinus by way of an osteoplastic flap in the temporal region. The dura mater is then loosened from the squamous and petrous portions of the temporal bone until the second and third divisions of the fifth nerve appear, when the sinus will be located above the second division of the fifth nerve, the first division lying in the outer wall of the sinus itself.

These operations, while presenting the probability of injury to

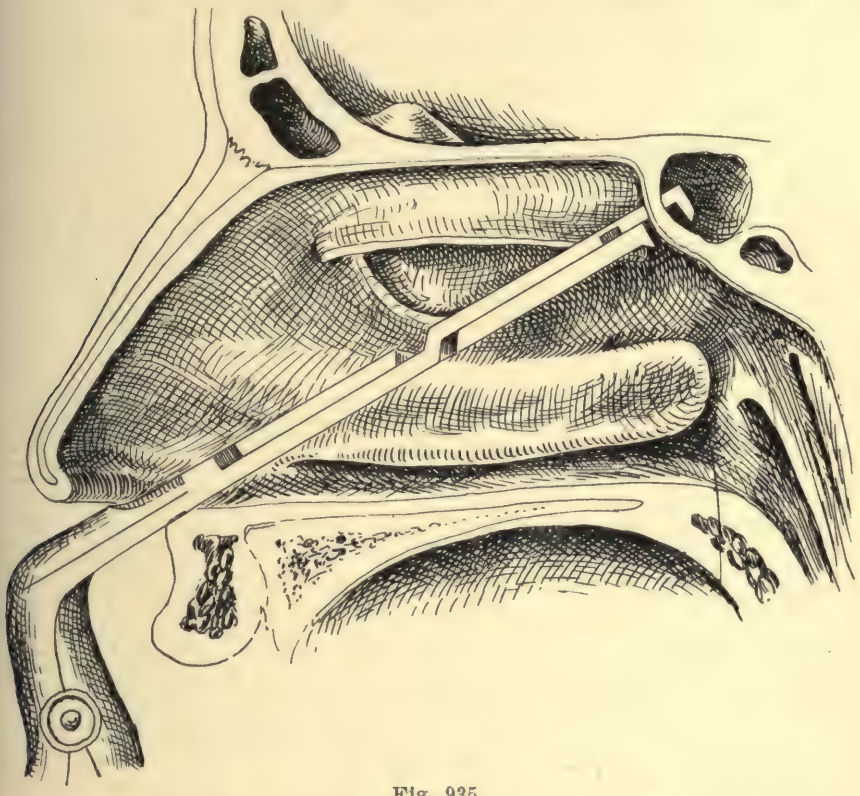


Fig. 935.

Sphenoidal Sinus Operation. Removal of Anterior Wall of the Sphenoid Sinus with the Hajek Forceps. (After Ballenger.)

the optic nerve and carotid artery, offer some hope of relief to a patient who is practically certain to die and in whom the optic nerve and globe have already been damaged.

[78]Hartley and Krause. *International Text-Book of Surgery*, Vol. VIII, p. 866.

PART VIII.

OPERATIONS ON DISTANT ORGANS FOR THE RELIEF OF EYE SYMPTOMS.

By A. E. HALSTEAD, M. D., Chicago, Ill.

Operations for Relief of Optic Neuritis and Choked Disc—Definition of the Term "Choked Disc"—Pathogenesis of Choked Disc—Etiology of Choked Disc and Optic Neuritis—Craniectomy for Exploration and Decompression—Operative Procedures for Special Indications—Special Procedures in the Removal of Cerebral Tumors—Technique of Operations on the Hypophysis Cerebri—Dangers and Complications of Intracranial Operations; Their Avoidance and Treatment—Dangers at Time of Operation—Post-Operative Dangers and Complications—Brain Puncture—Indications for Cerebral Puncture—Technic and Location of the Brain Puncture—Technic of Simple Puncture—Spinal Puncture—Therapeutic Indication of Spinal Puncture—Technic of Spinal Puncture—Surgical Treatment of Exophthalmic Goitre—Indications for Operative Treatment of Exophthalmic Goitre—The Author's Technic for Operating on the Thyroid in Graves' Disease—Dangers and Complications of Thyroidectomy—The Results of Partial Thyroidectomy for Exophthalmic Goitre—Intraglandular Thyroid Enucleation—Resection—Enucleation of Kocher—Incision and Drainage of the Thyroid—Exothyropexy in Graves' Disease—Ligation of Thyroid Arteries—Technic of the Ligation of Both Superior Thyroid Arteries—Ligation of the Superior Poles of the Gland—Operations Upon the Cervical Sympathetic—Technic of Total Unilateral Sympathectomy—Pulsating Exophthalmus and its Operative Treatment—Orbital Operations—Technic of Ligation of Common Carotid—Ligation of the Internal and External Carotid.

OPERATIONS FOR RELIEF OF OPTIC NEURITIS AND CHOKED DISC.

Definition of the Term "Choked Disc."

It is generally conceded that every so-called "choked disc" passes through a stage of "papillitis" or "optic neuritis" before attaining its full development; and that almost any optic neuritis may go on to the "choked disc." For these reasons and because the operative relief in both conditions is identical, we here group the two conditions together, as does Oeller[1] in his well-known *Atlas*, for the sake of con-

[1]Oeller. *Atlas der Ophthalmoskopie*, 1899.

venience, without prejudicing ourselves as to the presence of an actual inflammation in each case, or the degree of the swelling.

Gowers defines a choked disc as an optic neuritis of four diopters height.

Some Viennese ophthalmologists fix the limit at three diopters. These quantitative differences seem to us of little practical importance in the absence of corresponding differences in etiology, pathology, clinical significance and treatment.

Pathogenesis of Choked Disc.

In spite of the attempts of the advocates of the two different theories, the *mechanical* and the *inflammatory,* to attribute all cases of optic neuritis and choked disc to one common pathogenesis, it is becoming more and more evident that different pathological processes may produce the same macroscopic and microscopic picture in the optic nerve and disc. Since our conception of the pathogenesis is the basis for treatment, we may be permitted to enter into it in some detail.

When v. Graefe[2] first gave the name *"Stauungspapille"* to this condition, he considered it due to venous congestion in the optic veins, because in some cases, even with hemorrhages present, he found no signs of inflammation in the nerve.

Virchow,[3] on the other hand, found inflammation of the nerve trunk in a case of meningitis with disc changes of only moderate degree, which he assumed to have been communicated to the nerve from the meninges, and to this form Graefe gave the name "descending neuritis."

Therefore, even in Graefe's time, we find, just as to-day, a twofold pathogenesis of optic neuritis.

The "descending neuritis" was supposed to be characterized ophthalmoscopically by only a slight degree of swelling in the disc and a tendency to invade the retina; while the cases associated with increased intracranial pressure *("Stauungspapille"* of Graefe, or "choked disc" of Clifford-Allbutt, e. g., tumor, were characterized ophthalmoscopically by a high degree of swelling limited to the disc, the retina remaining more or less unaffected.

We now know that these ophthalmoscopic differences, as given above, are artificial, and that cases associated with high intracranial pressure may present only a slight disc change, or none at all, while meningitis, pyemia, intoxications and other conditions associated with

---

[2]v. Graefe. *Gazette Hebdom.*, November, 1859. See, also, Ueber Complication von Sehnervenentzündung. *Arch. f. Ophth.*, VII, 1860, pt. 2, p. 59.

[3]Virchow. Ueber Complication von Sehnervenentzuendung mit Gehirnkrankheiten. *Arch. f. Ophth.*, VII, 1860, pt. 2, p. 58. Also, Tumor Orbitæ et Cerebri, *Arch. f. Ophth.*, 1866, XII, p. 100.

a "descending neuritis," and without other evidence of increased intracranial pressure, may present the typical appearance of choked disc, so that we no longer attempt to make an ophthalmoscopic, etiologic diagnosis between "descending neuritis" and "choked disc."

Graefe considered that choked disc was produced by the increased intracranial pressure damming back the circulation of the eye by pressing on the cavernous sinus. He thought that this mechanical effect was still further enhanced by the effect of the rigid scleral foramen.

This theory of pressure on the cavernous sinus received a severe setback, in 1869, when Seseman[4] showed that the communication between the orbital and facial veins is so free that pressure on, and even obliteration of, the cavernous sinus produces no intraocular changes. This was further corroborated by Hutchinson's[5] case, in which complete obliteration of the cavernous sinus by pressure from aneurysm produced no eye changes.

It was Schwalbe,[6] in 1869, who first showed that the subvaginal space around the optic nerve is continuous with and can be injected from the subdural space, and who pointed out the significance of the fact in connection with choked disc.

Carion,[7] Manz[8] and Schmidt[9] [Rimpler] showed how frequent is the distension of the optic sheath in neuritis, and tried to produce optic neuritis by injecting the subdural space with fluid; and in some cases a transient swelling and redness of the disc resulted, but no typical neuritis.

Schmidt [Rimpler] found that fluid injected into the sheath passed into the lymph spaces in the nerve at the *lamina cribrosa*, and he suggested that pressure *inside* the nerve and perhaps irritation from the fluid in the nerve causes the neuritis.

Schmidt's and Manz's views were widely accepted in Germany.

Leber threw his influence in favor of the inflammatory theory, in 1881, in a discussion at the International Medical Congress, in London, and here first used the term "papillitis." He rejected the theory of Manz that the fluid acts by mechanical pressure, and also failed to verify the connection between the sheath and lymph spaces of the nerve,

---

[4]Seseman. Die orbitale Venen des Menschen und ihr Zusammenhang mit den oberflächlichen Venen des Kopfes, *Reichert, u. du Bois-Reymond's Arch.*, 1869, p. 154.

[5]Hutchinson. Quoted by Gowers, *Medical Ophthalmoscopy*, p. 75.

[6]Schwalbe. *Cbl. f. Med. Wiss.*, 1869, p. 465.
Arch. f. Mikroskop. Anat., VI, 1870, p. 1.

[7]Carion. *Ophthalmologie vom naturwissenschaftlichen Standpunkte aus bearbeitet.*, II, 1856, p. 612.

[8]Manz. *Zehender's Klin. Monatsbl.*, III, 1865, p. 281. *Deut. Arch. f. Klin. Med.*, IX, 1871, p. 339.

[9]Schmidt. Zur Entstehung der Staungspapille (Neuritis optica intraocularis) bei Hirnleiden. *Arch. f. Oph.*, XV, 1869, p. 193.

asserted by Schmidt-Rimpler. He assumed that the fluid in the sheath excited neuritis by conveying pathological material into the optic nerve behind the eye. Deutschmann[10] published additional evidence in favor of Leber's theory.

Other theories of the origin of optic neuritis which have arisen only to be discarded are: (1) the "foreign body" theory of Hughlings Jackson[11] and Brown-Sequard; (2) Vaso-motor theory of Benedikt;[12] (3) Inflammation by continuity theory of Galezowski; (4) Basal meningitis theory of Edmunds and Lawford;[13] (5) Theory that neuritis optica intraocularis is the expression of a general cerebral edema, the effect of distension of the ventricles of the brain (of Parinaud).[14]

In more recent years the Schmidt-Manz mechanical theory has been upheld by Schulten, Bramwell, Oppenheim, Hoche, Merz, as well as v. Bruns and Cushing. Uhthoff, Saenger, Axenfeld, and Kampfferstein speak of rigid lamina cribrosa, in addition to increased intracranial pressure, as furthering intraocular passive congestion.

The Leber-Deutschmann theory has been vigorously upheld by Knies, Gowers, who believes in a descending neuritis, Elschnig, who first used the term papilledema, Jacobson and Fleming.

But whether the process in the nerve and nerve-head is inflammatory in nature (as evidenced by round-cell infiltrations, exudate, edema, hemorrhages, increase of nuclei), or merely a passive congestion and edema, it is certain that in the great majority of cases, and particularly in those in which an increase in intracranial pressure is demonstrable, decompressive operations lead to retrogression of the eye conditions, and even to the complete or almost complete recovery of vision in eyes previously nearly, though rarely quite, blind.

The time of election for operation in these cases is the beginning of loss of vision. Later operation, when atrophy is advanced, cannot restore the damaged nerve cells.

Etiology of Choked Disc and Optic Neuritis.

The following conditions are those in which *neuritis optica intraocularis* and choked disc more commonly occur:

A. *Intracranial Conditions:*

1. *Tumor cerebri* is by far the most frequent cause of choked

---

[10]Deutschmann. *Neuritis optica, besonders die sogenannte Stauungspapille*, Jena, 1887.

[11]Jackson. **The Surgical Treatment of Choked Disc.** ***Oph. Hosp. Rep.*****, Vol. IV, 1883, p. 407.**

[12]Benedikt. ***Allg. Wien. Med. Zeit.*****, 1868, No. 3.**

[13]Edmunds and Lawford. ***Trans. Oph. Soc.*****, I, p. 111; III, p. 138; IV, p. 172; V, p. 184; VII, p. 208.**

[14]Parinaud. De la Nervite Optique Dans Les Affections Cérébrales. ***Ann. de'Ocul.*****, LXXXII, 1879, p. 5. Also *Graefe-Saemisch Handbuch*, Bd. V.**

[15]Birch-Hirshfeld. ***Archiv. f. Ophthalm.*****, 65, p. 440-485.**

disc. In 200 cases of Kampfferstein's[16] of choked disc, 134 were due to brain tumor. Had cerebral syphilis and conglomerate tubercles been added, the number would have been raised to 170.

Gowers[17] holds that tumor cerebri is also the most frequent cause of optic neuritis, though R. Greeff[18] is inclined to give the precedence to the various forms of meningitis.

The location of a tumor is of much more importance in the production of choked disc than its microscopic character or specific etiology. In general, it may be said that the tendency of tumors to produce choked disc increases from the anterior to the posterior pole of the brain, and diminishes from the cortex inwards. Also choked disc is somewhat more likely to occur earlier and reach a higher degree on the same side as the tumor.

Paton,[19] in reviewing 252 cases of brain tumor, found that tumors of the cortex are more liable to produce optic neuritis and choked disc than tumors of the subcortical white matter and pons, and that the intensity of the neuritis in tumors of the cerebral cortex varies inversely with the distance of the part affected from the anterior end of the middle fossa.

Age is an important factor in the production of choked disc by tumor, youth being much more liable to develop it than age. H. L. Singer,[20] in reporting 88 cases of brain tumor, showed that the average age of 51 cases with well-developed choked disc was 28 years, and of 9 cases without choked disc was 54 years.

Heredity, sex, nationality, occupation play little, if any, rôle.

Tumors of the posterior fossa are especially liable to produce choked disc. They are cerebellar cysts, hemorrhages, sarcoma, glioma, psammoma, endothelioma. The cerebellum is also the location of predilection for conglomerate tubercles and otitic abscesses.

Cerebello-pontine angle tumors most often grow from the acoustic nerve; less often from the adjacent nerves, corpora quadrigemina or cerebellum. Acoustic tumors are usually fibromata, sarcomata and less often psammomata, and not rarely may be bilateral.

Basal tumors and hemorrhages (also of the corpora quadrigemina, pons, medulla, pineal gland, etc.) produce choked disc much less often than the two groups above, perhaps because, owing to early involvement of vital parts, they produce death before they arrive at the choked-disc-producing stage.

---

[16]Kampfferstein. *Klin. Monatsbl. f. Augenheilk.*, April-June, 1906.
[17]Gowers. *Medical Ophthalmoscopy*, 1904, p. 71.
[18]Greeff, in Axenfeld's *Lehrbuch der Augenheilkunde.*, 1909, p. 553.
[19]Paton. Optic Neuritis in Cerebral Tumors. *Trans. Ophth. Soc.*, Vol. XXVIII, p. 112.
[20]Singer. *Lancet*, June 14, 1902; quoted in *Year Book of Pract. Med. Series*, 1902, p. 58.

Hypophysis tumors and cysts (occasionally gumma and rarely tuberculoma) occasionally produce choked disc, but set up optic neuritis somewhat oftener.

The characteristic eye findings of hypophysis tumor are bitemporal hemianopsia, as a rule; binasal hemianopsia, rarely; bitemporal

Fig. 936.

Subcortical Tumor. The dilated veins and discolored, uneven cortex enable us to locate such subcortical tumors at operation. Any one of these three characteristics is enough to act as guide for an exploratory incision.

atrophy, atrophy in varying grades of one or of both eyes, or hemianopsia with atrophy. They usually find an adequate explanation at *post-mortems* in direct pressure of the tumor on the optic tracts or chiasm, and less frequently on the optic nerves themselves, to reach

which a pituitary tumor must be very large and must have a very unusual forward extent.

Erdheim[21] has shown and depicted the mechanism by which both optic tracts may be caught between the growing hypophysis tumor and the carotid arteries, and crushed between them. Erdheim, in 1909, had another similar case, an unsuccessful attempt at extirpation by Hochenegg, with death from hemorrhage, and in this case the two very rigid sclerotic carotids acted as unyielding bands, between which and the large pituitary tumor the optic tracts had been compressed to a thin, scarcely perceptible transparent ribbon. The patient, needless to say, was completely blind before the operation.

Perhaps the very rare cases of pituitary tumor with binasal hemianopsia are due to such a condition, the pressure of the carotids on the temporal fibers of the tract making itself felt before the pituitary tumor itself has brought about a distinct lesion in the nasal fibers.

From the mechanical theory of optic tract lesions in hypophysis tumors, Schnabel[22] seems to be the chief dissenter. His theory, brought forth in 1906, that the bitemporal hemianopsia is of toxic origin, due to the direct action of pituitary toxin on the nerve fibers, and likening the condition to toxic central scotomata, has not found much support. Physiological and chemical researches since that time, while they have considerably enlarged our knowledge of the pituitary secretion and its functions, have not as yet demonstrated a neurotoxin sufficiently active to produce, unassisted, so severe a nerve lesion as that occurring commonly with pituitary tumor. Moreover, since the appearance of Schnabel's article, the relief experienced from operative procedures in patients, in most of whom only a partial extirpation of the gland has been performed, speaks rather strongly against the toxic, and for the pressure, theory.

Cortical tumors (those above the tentorium) do not usually develop neuritis, though they do so more often than tumors of the subcortical white matter. From the point of view of diagnosis and treatment, these tumors should be divided into those of the (1) sensorimotor area; (2) occipital lobe; (3) temporal lobe; (4) frontal lobe: and also those arising from the (1) meninges; (2) outside the meninges (in the bone and outer surface of the dura); (3) cortex; (4) subcortical white matter and spreading to the cortex.

Cerebral cysts almost deserve a chapter to themselves, owing to their peculiar, varied and often etiology, as well as the problems which they present in diagnosis and treatment.

---

[21]Erdheim. *Ueber Hypophysenganggeschwülste ü Hirn Cholesteatome*, p. 120, 1904.

[22]Schnabel. Bitemporal Hemianopsia, *Oph. Year Book*, 1906, p. 168.

They are (1) primarily cystic tumors; (2) solid tumors with secondary cystic degeneration; (3) traumatic cysts—(a) hemorrhage with subsequent absorption; (b) encephalomalacia, etc.; (4) connective issue cysts of Krause; (5) parasitic; (6) lymphatic, etc., etc.

2. *Brain abscess* is, according to Oppenheim,[23] who has reviewed the literature up to 1909, in 30 to 50 per cent. of the cases of (a) *otitic origin*. These otitic abcesses are located either extradurally, in the cerebellum, or in the temporal lobe. They are mentioned here in the order of their frequency.

(b) *Disease of the accessory sinuses* produces brain abscess much less often than ear disease. The location of these abscesses is usually either subdural at the base, or in the frontal lobes.

(c) *Abscess following injury* may be located anywhere, depending on the site and nature of the trauma.

(d) *Pyemic and metastatic abscesses* may occur anywhere and do not show the same uniform tendency to attack the region of the basal ganglia that embolic hemorrhages show. We may also mention (e) *brain abcesses occurring with bronchiectases and other purulent affections of the lungs.* The route of infection of the brain here is not always entirely clear.

3. *Intracranial hemorrhages* are much less frequently the cause of choked disc than the above-mentioned causes. In fact, in the great majority of cases, even with massive hemorrhages into the meningeal spaces, there are no changes in the eye grounds. Why swelling of the disc is present in the small minority of cases and absent in the others is difficult at present to state, but it seems in line with the relatively small tendency of cortical disease in general to produce choked disc.

4. *Sinus thrombosis* in two-thirds of the cases produces no eye changes. Why in some cases and not in others is difficult to say. It cannot be a matter of restriction of the outflow from the ophthalmic veins, since many cases of complete blocking or thrombosis of the cavernous sinus, as first reported by Hughlings Jackson,[24] show no fundus changes, the blood escaping freely from the ophthalmic veins by way of the facial and angular veins and their tributaries.

5. *Meningitis* is a very common cause of optic neuritis (i. e., of a moderate degree of papillitis), but rarely of actual choked disc.[25]

Epidemic meningitis is a frequent cause of optic neuritis, of which it is often one of the earliest and most valuable signs, as demonstrated by a case seen by the author at Cook County Hospital in January,

---

[23] Oppenheim. *Der Hirnabscess*, Berlin, 1909, p. 67.

[24] Jackson. The Surgical Treatment of Choked Disc. *Ophth. Hosp. Rep.*, Vol. IV, 1883, p. 407.

[25] Greeff. Kampfferstein. loco cit.

1910, in which an examination-room diagnosis of lumbago was changed to one of epidemic meningitis by the finding of a bilateral optic neuritis. This led to a lumbar puncture, resulting in finding pus and the diplococcus intracellularis.

Choked disc, when it does occur in meningitis, is apt to appear late in the disease, when the acute symptoms have disappeared. A remnant of exudate, more or less organized, blocks the foramina of exit of the fourth ventricle (foramina of Magendie, Key and Retzius), and causes an internal hydrocephalus.

Tuberculous meningitis leads to optic neuritis only in rare cases. Tubercles in the choroid are almost as common here as optic neuritis. Choked disc occurs chiefly where large conglomerate tubercles, particularly in the cerebellum, complicate the disease.

Meningitis from other causes (pneumococcus, streptococcus, influenza and pyogenic cocci) leads to optic neuritis in a percentage of cases lying between the two above forms. Choked disc occurs chiefly when they are accompanied by brain abscess, internal hydrocephalus, or pyocephalus.

6. *Hydrocephalus internus*, particularly in the chronic form, is a frequent cause of the higher degrees of optic neuritis, choked disc and post-neuritic atrophy.

Whether choked disc in these cases be due to hydrops of the sheath of the optic nerve, edema of the nerve itself, or to pressure of the dilated third ventricle on the chiasm, is not certain. At any rate, it seems likely that the last occurrence may explain the sudden, transient and recurring amblyopias which are an alarming symptom in some brain tumors associated with internal hydrocephalus.

7. *Aneurysm of the cranial arteries*, most usually at the base (carotids, vertebral, basilar, circle of Willis, arterio-venous aneurysm, etc.), is one of the rarer causes of choked disc.

8. *Cranial deformity*, particularly the *"tower skull,"* which is often associated with an internal hydrocephalus, is a more frequent cause of the swelling of the disc than *exostoses*, which occasionally, though rarely, present the only demonstrable cause for an existing optic neuritis, which may disappear on their removal.

9. *Brain syphilis* produces choked disc chiefly in the gummatous stage, or when associated with hydrocephalus.

Optic neuritis is, however, common, though usually unilateral in the secondary stage, occurring especially along with the second and third roseolar eruptions, rupia, condylomata, iritis, etc., rather than with the primary eruption.

10. *Ear disease*. It is chiefly the intracranial complications which lead to optic neuritis, especially abscesses, suppurative meningitis,

meningitis serosa, and sinus thrombosis. In a certain,[26] though small, number of apparently uncomplicated cases of otitis media there may develop an optic neuritis. It has, however, been noted that later these cases are more apt to present intracranial complications than are those without the accompanying neuritis. Menière's disease may also occasionally be accompanied by an optic neuritis, perhaps due to the same cause which produces the trouble in the inner ear or vestibular tract.

11. *Encephalitis* producing any eye symptoms causes optic neuritis of low grade, and very rarely, if ever, choked disc, unless abscess formation intervenes in addition. Encephalitis occurs with acute poliomyelitis with accompanying acute polioencephalitis, scarlet fever and the other exanthems, meningo-encephalitis and trauma.

12. *Post-operative neuritis,* as pointed out by Cushing[27] and de Schweinitz and Holloway,[28] though a rare complication of exploratory and decompressive measures, may occur in eyes previously normal. The more usual occurrence, however, is that a previously existing optic neuritis or choked disc for a few days or a couple of weeks after the operation shows a slight or moderate increase in intensity before it gradually disappears or goes over into a secondary atrophy.

B. *Other less important optic conditions,* causing optic neuritis, which, however, may be mistaken for those demanding surgical intervention, are multiple sclerosis, paretic dementia, nephritis (neuritis or neuro-retinitis), neuritis of pregnancy and puerperium, neuro-retinitis leukemica.

Intoxications, especially with metallic salts, are more apt to produce retrobulbar neuritis than neuritis optica intraocularis, and also are very apt to lead to optic atrophy, e. g., arsenic, lead, mercury, alcohol (ethyl and methyl), tobacco, etc.

Lightning stroke is said to be a cause of optic neuritis, but the so-called *"Berlinische Trübung"* is a more frequent fundus change.

C. *Orbital disease* is a frequent cause of optic neuritis and choked disc, which is, however, with rare exceptions, unilateral.

The particular varieties of orbital disease causing swelling of the optic disc, especially those secondary to inflammations or tumors of the accessory sinuses of the nose, are treated elsewhere in this work, and will therefore not be discussed here.

---

[26]Barr and Rowan. Optic Neuritis with Disease of the Ear. *Ophthalmic Year Book*, 1908, p. 245.

[27]Bordley and Cushing. Observations on Choked Disc. *Jour. A. M. A.*, Jan. 30, 1909, LII, p. 355.

[28]de Schweinitz and Holloway. The Operative Treatment of Papilledema Dependent on Increased Intracranial Tension. *Therap. Gaz.*, July 15, 1909, Vol. XXV, No. 7, p. 474.

CRANIECTOMY FOR EXPLORATION AND DECOMPRESSION.

Indications.

Since almost every operative procedure on the cranial vault has *exploration* more or less directly as its aim, and since where exploration fails to detect the disease decompression relieves the symptoms, we find this particular operation the most frequently performed and important in our work. Brain puncture, tumor removal, abscess drainage, removal of blood clots, control of hemorrhage, drainage of the ventricles, etc., etc., may be combined with it. Therefore, together with its modifications, it includes nearly the entire field of cerebral surgery.

The conditions for which it is commonly done are the following:—(1) *tumor cerebri,* localizable and not localizable, and particularly when associated with choked disc and pressure symptoms; (2) *brain abscess;* (3) intracranial hemorrhages; (4) hydrocephalus rarely, unless associated with brain tumor. Usually brain puncture is done here in preference to craniectomy. (5) Brain syphilis which does not yield readily to specific treatment; (6) encephalitis in some cases when associated with increased tension and causing optic neuritis or choked disc; (7) edema of the brain in uremia has been considered an indication by Cushing,[29] but is a doubtful one; (8) in general, any condition associated with increased intracranial pressure and swelling of the optic disc demands for the relief of pressure symptoms and optic nerve changes an exploratory operation, which may be later turned into a remedial operation whose character will depend on whatever pathological condition be found; or into a decompressive or palliative operation if nothing accessible be found.

Preparation. In my clinic, on the day before the operation the patient's head (whole head, if a man; something less than half the head, if a woman) is shaved, scrubbed with tincture of green soap on gauze, rinsed with sterile water, then with alcohol, and then with 1:1000 bichloride. A dry dressing is then applied. This procedure is again repeated on the operating table before the operation.

A double layer of gauze (either dry or wet and wrung out of a solution of 1:1000 bichloride) is then applied to the entire cranium and over this the rubber constrictor. As a rubber constrictor, I use an India rubber band, one inch wide and eight inches in circumference, which can be obtained of any house handling rubber goods. I make two or three turns with it around the head, which I find is constriction enough. There is no buckle to fasten; it never slips; so that tapes, as

---

[29] Cushing and Bordley. Subtemporal Decompression in a Case of Chronic Nephritis with Uremia. *Am. Jour. Med. Sc.*, Oct., 1908, pp. 484-504.

used by Cushing are unnecessary, and the cost is a few cents only. The patient is then ready for the initial incision.

Anesthesia. Before the patient is brought to the operating room he is given a hypodermic of morphine, ¼ grain; atropine, gr. 1/100, or if the patient be small, or a woman, 1/6 and 1/150 gr., respectively.

Ether, by the drop method, is, as a rule, the anesthetic of the

Fig. 937.

Author's Method of Controlling Hemorrhage from the Vessels of the Scalp by means of a Large Rubber Band.

entire operation. But in some cases, especially when for one reason or another speed is necessary, the anesthetic is started with nitrous oxide and oxygen.

Position of the Patient. For temporal and motor area operations and in general for all operations on the anterior half of the cranium, the patient lies on his back, with head and shoulders raised, and an-

esthesia is administered as for any other operation. The operator and his assistants are, however, separated from the anesthetist by the laparotomy sheet, which is held up between the field of the operation and the field of the anesthetist by an outrigger attached to the table.

For suboccipital operations and frequently for any operation on the posterior half of the cranium, the anesthetic is given and the operation performed with the patient lying on his face, the forehead supported on a head-rest in the form of a bracket attached to the head end of the table; with sand-bags under each shoulder, to leave the chest relatively unrestrained for breathing.

Fig. 938.

Curtis-Halstead Table (St. Luke's Hospital, Chicago). Sandbags under the shoulders; outrigger for the forehead. Gauze over the head secured by a Halstead rubber band.

The anesthetist sits on a low stool and is covered by the laparotomy sheet drawn over the patient's head. The anesthetist, for his own comfort, wears a rubber cap and a rubber apron, closely tied about his neck, to protect his clothing.

We do not believe in further incommoding our anesthetist with a phonendoscope, as recommended by H. Cushing,[30] unless it be im-

[30]Cushing. Some Principles of Cerebral Surgery, *Jour. A. M. A.*, Jan. 16, 1909, LII, p. 187.

possible to secure another assistant especially for the purpose of watching pulse and respiration. The extra assistant is easily obtained in any large hospital, and the anesthetist has his hands fully occupied and is in discomfort enough without being put to this extra inconvenience.

Occasionally the Matas apparatus is used. Air saturated with chloroform vapor is led into the patient's retronasal space by means of a rubber catheter introduced through the nose. When this apparatus is used the patient is put to sleep by the usual mask method, and just before the operator is ready to begin, the nasal catheter is inserted and anesthetic continued with the apparatus. The anesthetist is thus completely removed from the field of operation. Because only a relatively small amount of anesthetic can be administered by this method, it is usually desirable to use chloroform instead of ether, especially with large and fat patients and alcoholics.

The incision is usually marked out on the scalp with iodine just before the double layer of gauze and the tourniquet are applied, so that the still wet iodine stains through the gauze. In locating the incision measurements are usually dispensed with. The eye of the surgeon who is constantly employed in cranial work becomes as accurate as any of the craniometers on the market, and it is, moreover, always easy to enlarge the opening in any direction subsequently desired.

The incision is semicircular, to form a flap with the base in the direction of the blood supply. The first cut is made down to the lamina externa.

At this point there is always some little hemorrhage from the vessels of the galea, but it is usually easily controlled by (1) promptly turning the flap back and exerting pressure on it, provided that an osteoplastic operation is not to be done; (2) by catching and twisting with sharp Kocher forceps, or ligating the "spurters" with fine catgut, No. 1; (3) by pressure by an assistant with gauze along the margins of the incision. If the rubber tourniquet is used, the hemorrhage is insignificant.

The other measures sometimes recommended for stopping this hemorrhage we have never found necessary to use, and believe that in this we are sustained by the best American practice.

The running stitch of Jacob Frank, of Chicago, later modified by Heidenhain, and known abroad by the latter's name, would be useful, but is scarcely necessary even though the tourniquet be not used, as, for example, in suboccipital and subtemporal decompressions. To keep these stitches in place for eight to ten days, as Heidenhain recommends, seems to us not only unnecessary, but even dangerous to the

health of the flaps, and certainly predisposes to slow healing of the wound and, therefore, frequent loss of cerebrospinal fluid.

Kredel's plates we have even less use for than Frank's ingenious stitch.

Attacking the bone. If an osteoplastic resection is to be made, we proceed at once to bore through the skull. If merely a decompression is desired, we first strip back the periosteum with the skin flap.

Bone instruments. We have tried them all and have come back to the trephine or Hudson burr, supplemented by the De Vilbiss forceps.

All electric-driven machinery we have discarded—burrs, drills, rotary saws, etc., etc. They are all wrong in principle because they open the skull from without inwards and therefore expose the brain to injury from excessive penetration and bone splinters. They are all liable to slip at times, even in the hands of the most experienced men, as our dental colleagues can testify, and cut undesired gashes in the bone and scalp. Moreover, their greater speed is largely offset by their liability to get out of order, thus causing long delays, and leading to faulty asepsis. Again, they are impossible to sterilize *in toto* and slipping towels in the course of long operations are apt to leave non-sterile parts exposed to the surgeon's touch.

The *mallet* and *chisel* we have discarded because (1) of the time consumed in entering the skull, and (2) for the reason that we believe the repetition of blows upon the skull may possibly, as claimed by many, produce cerebral concussion.

I have been very well pleased with the Hudson burr. Its chief value is not the rapidity with which it can be operated, but in its mechanical construction, which is so adjusted that when the teeth of the burr strike non-resisting dura they cease to bite, thus making injury to the dura and underlying brain impossible, even when considerable manual force is applied.

The trephine opening is made large enough to admit a De Vilbiss cutting forceps and with the latter the bone incision is enlarged in the direction of and parallel to the skin incision, or as desired, but keeping well inside the latter, in order to avoid overlapping of the bone and galea incisions.

If an osteoplastic flap is to be made, the bone incisions are continued around to the narrow base of the flap, which is then broken across by prying the flap with a bone elevator and perhaps also making cuts at the sides with a special chisel. (See illustration.)

Where an especially accurate reposition of the flap with avoidance of pressure on the dura is desired, a Gigli saw may be passed

from one trephine opening to the other and the intervening bone sawed through on a bevel.

A Braatz sound or similar dural separator and protector must be passed between dura and lamina interna and along this, as a guide, the Gigli saw is passed and manipulated.

I do not use the Gigli saw method, however, because of the ever-present danger of damage to blood vessels and brain in passing the sound and saw and in making the first few strokes. The method also has the disadvantage of being somewhat slow.

When it is desirable to *enlarge the bony opening*, a new flap may be made with the De Vilbiss forceps, or bone may simply be bitten away in the desired direction with the Macewen rongeur forceps.

Hemorrhage from the bone has now to be controlled and this is done by (1) pressure with gauze wrung out in hot salt solution and packed tightly against the bone; (2) packing the oozing bone with Horsley's wax or with muscle tissue from the cut galea; (3) acupuncture with any pointed instrument and mallet. A simple orange stick is cheap, easily sterilized and applied; 4. Crushing of the bleeding bone with the rongeur forceps is usually successful if other methods fail.

Hemorrhage from the dura and cerebrum occurs only when these are wounded, a rare occurrence with our technic. Occasionally a vein runs from the dura into the lamina interna of the cranial vault, and this may be cut through in the incision, but the resulting hemorrhage is controlled by ligating the vein on the dural side.

The dura now lies exposed before our eyes. By palpation with the finger-tips we estimate its tension, and whether it pulsates or not.

Where tension is much increased, marked pulsation is usually absent (depending on the relation of the intracranial tension to the blood pressure).

Also we must feel for any increase in local resistance, such as would indicate a tumor or infiltrate; or for signs of fluctuation, due to intracranial fluid or cyst formation.

The incision in the dura is next made. This may be either (a) cross-shaped, or a (b) flap, the pedicle of the flap being placed either (c) in the direction toward which further exploration and chipping away of the bone is to be done, or (d) in the opposite direction from the skin flap pedicle, to have an overlapping of the two flaps on closure of the wound, and thus prevent a brain prolapse and subsequent fungus cerebri.

When the pia-arachnoid lies exposed, a careful examination is again made. Pulsation is looked for; dilated blood vessels are duly noted, as an indication of an adjacent tumor; likewise differences in

color, prominence and smoothness of the surface. Any local tendency to obliteration of the sulci or flattening of the convolutions is regarded as an important localizing point. Palpation with the finger-tips of both hands is done to determine possible spots of increased resistance or fluctuation.

Exploratory puncture is then made into suspected areas and the tissue brought away by the needle is examined macro- and (at times) microscopically, to determine the presence of fluid, pus or tumor tissue. The search for brain-tissue cylinders by needle puncture, as recommended by Krause, we have found of not much value, and believe it to be dangerous.

Fenger, of Chicago, some years ago gave this method a considerable trial and invented a special needle for it, provided on one side with a slot with sharp edges. The needle was inserted into the brain, then turned around to cut out the cylinder of tissue. Fenger finally abandoned the procedure, however, owing to its dangers and unreliability.

Exploratory puncture for pus. We never make this *through* the dura; only after the membrane has been opened and the subdural space walled off by packing with several layers of iodoform gauze. (See illustration.) When this is done, the needle is inserted, and as soon as the pus pocket is located an artery forceps is inserted along the side of the needle into the cavity. The blades of the forceps are then spread as they are withdrawn, and thus a large opening is made, with probably less damage to nerve fibers and blood vessels than when a knife-blade is used. The cavity is then irrigated, usually with normal salt solution, and packed with iodoform gauze. During all these manipulations the subdural space is kept well walled off with the iodoform gauze, the outer layers of which are renewed when the irrigation is complete. Drainage to the exterior is then made by a knife thrust through the flap directly over the opening to the abscess cavity, and here the drain, either cigarette, spiral, or split rubber tube, is led out.

Closure of the wound is done in layers, with buried stitches of catgut and superficial stitches of silkworm gut. The dura is brought together and, when possible, the edges overlapped, unless decompression is aimed at, when it is left unsutured. Sutures are of No. 1 or 2 iodized catgut.

The bone flap is replaced, attached to the galea, but no sutures inserted in it. Periosteum, unless much stripped up, is left unsutured. Tension stitches of heavy silkworm gut are now inserted into the galea flaps and between them approximation stitches of light- or silkworm gut.

The wound is first washed with bichloride, 1:1000, then with alco-

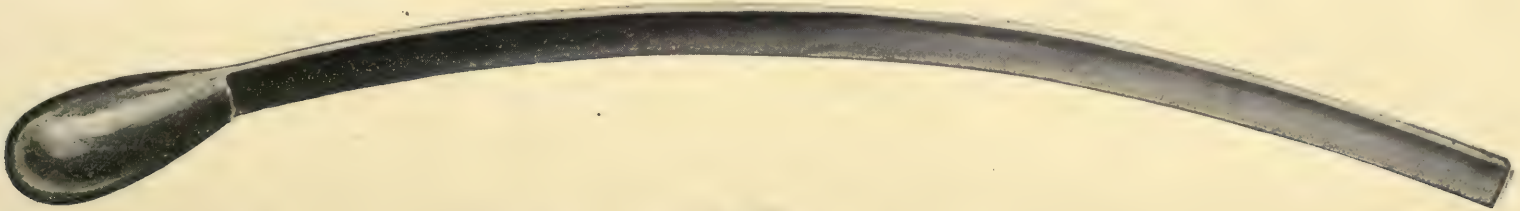


Fig. 939.
Krause's Flexible Sound for Exploration of the Subdural Space.

hol, and finally sealed with tincture of benzoin and silver foil; or, less frequently, with collodion on narrow gauze strips.

Fluffed gauze is then applied over the wound and, later, a "doughnut roll" of gauze is placed *around* the wound to protect the bony flap and brain below it from external pressure.

Over the whole bandage a large combination is then applied, and, lastly, a roller bandage held with adhesive strips.

Stimulation of the patient. Before the operation the patient's left cubital space is prepared so that an intravenous infusion of normal salt can be given instantaneously, if necessary. A hypodermoclysis apparatus for simultaneous administration of normal salt under both breasts at once is in readiness during the operation.

A hypodermic of thirty minims of camphorated oil, or 1/100 gr. digitalin, is given usually before the patient leaves the table, if any evidence of shock or collapse be present, and he is put to bed with his head low. On returning to consciousness, the patient is allowed to suck ice, or is given teaspoonfuls of hot water, whichever he prefers.

Normal salt enemata of a pint each are given at intervals of four hours for thirst and for purposes of stimulation.

Continuous rectal administration of normal salt solution I have never found as satisfactory as its administration at intervals, owing to the inconvenience the tube causes the patient and the constant soiling of the bedding.

If *post-anesthetic vomiting* is prolonged over twenty-four to thirty-six hours, the stomach is washed out with a couple of quarts of warm water, which usually gives prompt relief.

When vomiting has ceased, the patient is put on liquid diet, and, if convalescence is normal, a couple of days later on light diet, and at the end of the first week a general diet is allowed.

If there is considerable seepage of cerebrospinal fluid after the operation, the outer dressings are changed as often as saturated, and the inner dressings daily. Any stitches around which necrosis is threatening are removed at the daily dressings and necrotic tissue is promptly clipped away. Tincture of benzoin is applied to the cut surface, and is usually swabbed over the whole wound at every dressing.

When dressings must be frequently changed, they are retained by a large figure-of-eight bandage instead of the roller.

Where there is no discharge of the cerebro-spinal fluid, the dressings are not removed until the end of the first week, at which time the stitches are taken out, tincture of benzoin swabbed over the wound and the dressing reapplied for another week, at the end of which time it may be left off entirely. As long as cerebro-spinal fluid continues

to discharge, careful aseptic dressing must be continued. Use of the silver nitrate stick and tincture of iodine swabs hasten the closing of these fistulæ. Not infrequently they occur through a stitch puncture, especially if the stitch be left in too long. For this reason we often remove stitches as early as the fourth day, if the wound is well united, but usually from the fifth to the seventh day.

Occasionally a patient will suffer pressure symptoms when a long open fistula finally closes. In such cases it must be reopened and then again gradually allowed to close.

Patients are usually allowed to sit up on the third or fourth day and leave bed at the end of the first week.

OPERATIVE PROCEDURES FOR SPECIAL INDICATIONS.

I. Tumor Cerebri.

The general technic of exploration and decompression for cerebral tumor has been already described. It remains now to speak of (a) *subtemporal decompression* (H. Cushing[31]) for unlocalizable or inoperable tumors above the tentorium; (b) *suboccipital decompression,* usually bilateral, less often unilateral, for exploration and decompression in the case of disease located below the tentorium; and (c) special procedures practised in the removal of certain tumors.

The tumors are (1) cysts, (2) tubercles, (3) vascular tumors, (4) cortical and subcortical tumors, (5) capsulated and non-capsulated tumors and (6) hypophysis tumors.

It also remains to give briefly the technic of (a) hemostasis, (b) obliteration of the resulting cavity after tumor excision, (c) exploratory incision of the cortex, (d) the two-stage operation, and the (e) prevention of shock and collapse.

(a) *Subtemporal decompression* is done that the temporal muscle may reenforce the skin and galea in restraining post-operative *prolapsus cerebri* after decompressive procedures, thereby avoiding a fungus, with consequent dangers of septic infection of the brain and meninges. In my clinic a semicircular incision is made parallel to and one centimeter below the origin of the temporal muscle. Anteriorly, it reaches not quite to the hair border and, posteriorly, it runs somewhat lower, behind the pinna of the ear. Skin and superficial fascia are stripped downward toward the base of the flap, leaving the temporal muscle and fascia exposed. These are now separated bluntly in the direction of their fibers down to the periosteum. The two edges of the muscle are also separated to a maximum extent by blunt retractors. The periosteum is then incised and pushed back

[31]Cushing. Subtemporal and Suboccipital Decompression. *Surg., Gyn. and Obst.*, I, 1905, No. 4, p. 297.

with an elevator on both sides as far as possible. Then the cranial cavity is opened in the usual way, except that the bone is bitten away with the Macewen forceps over the entire area of the decompression. A dural flap is made with the base upwards, opposite the base of the skin flap. The decompression is thereby completed and it remains to close the wound. Catgut sutures unite the edges of the temporal muscle and fascia. The skin is sutured with silkworm gut. The

Fig. 940.

The Subtemporal, Submuscular, Decompression Operation of Cushing, showing Method of Separating the Temporal Muscle and of biting the bone away with Forceps. The dura has been opened.

usual dressing is then applied and the after-treatment is the same as for the decompression measures previously mentioned.

I have had very good results with the Cushing technic in so far as the prevention of prolapse is concerned. Occasionally it has not been possible to approximate the muscle edges closely, owing to the bulging of the brain. In this case I close the opening in the muscle

as well as possible below and trust to dural flap and skin sutures to control prolapse at the upper end of the opening.

The chief fault I have to find with Cushing's method is that the

Fig. 941.
Subtemporal Decompression.

area is not always a silent one. Paresis of the face and arm center at the lower end of the Rolandic area is not rare, and I have seen one case in which the leg center was involved in the resulting prolapse.

Cushing himself now uses a straight vertical incision in place of the flap, but I still prefer the older method.

(b) *Suboccipital decompression* is a very useful procedure for tumors below the tentorium and much preferable in these cases to decompression over the hemispheres, as recommended for this class of tumors, as well as for the supratentorial tumors, by Horsley.

The important feature of Cushing's operation is that the cerebellum is exposed on both sides at once, so that the entire posterior surface lies free to the view; the whole organ can be dislocated in any direction, and especially laterally, so that its other surfaces can be explored, as well as the adjacent basal ganglia, nerves, bone, dura and tentorium. The tentorium may also be incised through this opening and the overlying occipital lobes exposed.

Cerebellar tumors and cysts and acoustic and cerebello-pontine-angle tumors are well seen and attacked by this method.

The operation has the additional advantage that the bone need not be preserved, the thick nuchal fascia and muscles serving as a thoroughly adequate protection to the cerebellum against post-operative prolapse and trauma. It is easy to preserve the periosteum here and, eventually, there may develop some new bone, though not often.

Technic. The tourniquet cannot be applied to this locality, so that other measures for hemostasis must be relied upon, chief among which are rapid operating, pressure on the flaps by an assistant and prompt catching and twisting, or ligating, of bleeding points.

Incision for suboccipital decompression. I use the incision of Cushing in preference to that of Krause. A horizontal cut is made through skin and galea at the level of the external occipital protuberance, and this incision is continued two and one-half to three inches on each side of the middle line. Then, beginning at the external occipital protuberance, a cut is made in the middle line through skin, nuchal muscles and fascia down to the level of the second or third spinous process.

Hemorrhage at this stage is free and is best controlled by rapidly pushing the flaps up from the bone, turning them back, and having an assistant exert pressure on them. The assistant may also catch the chief bleeders with Kocher's forceps while he is exerting pressure on the flaps.

A trephine opening in the occipital plate is then made and the De Vilbiss forceps used to enlarge it, and ultimately the rongeur forceps also, since there is no particular object in preserving the bone in this well-protected locality.

Particular care must be taken to avoid wounding the venous

sinuses or, where it becomes necessary to cut through them, to ligate them in advance.

The occipital sinus is usually impossible to preserve, but the transverse sinuses must be spared, at least on one side. The sinuses are best protected by separating the dura from the bone with a Braatz or similar probe, well in advance of the rongeur forceps.

When the bone has been removed the whole posterior surface of the cerebellum lies exposed to view and may be easily dislocated in any direction to assist exploratory and operative procedures.

Closure is as previously described for any decompressive operation.

Acusticus tumors are best attacked by this method, the dislocation of the cerebellum to one side allowing of a very free exposure of the cerebello-pontine angle and permitting of total extirpation of tumors, parts of which might easily have been left behind in the old unilateral procedure, to say nothing of the much diminished danger of trauma to the cerebellum and danger of shock, collapse and respiratory failure from pressure on the medulla. It is also much less frequently necessary to sacrifice part of the cerebellum in order to enlarge the field, as was the case in the older operations.

(c) Special Procedures in the Removal of Cerebral Tumors.

Certain varieties of tumors require special methods of attack.

1. *Cysts,* unless they lie in the cortex, are usually located by exploratory puncture or exploratory incision of the cortex. After they have been located by the needle mere aspiration is, however, usually not sufficient for a cure. If left to themselves, they are very apt to refill and cause a recurrence of symptoms. Therefore, every cyst should be well opened up and packed or drained, so that it will have an opportunity to become obliterated.

If there be present a well-marked cyst wall, it should, as a rule, be excised, if possible, and such excision is imperative in the case of parasitic cysts.

The entire wall of the cyst should be carefully explored before the packing is inserted, so that any tumor nodes will not be overlooked. Certain tumors, e. g., glioma and sarcoma, are very apt to undergo cystic degeneration, which may reach such a high grade that the tumor itself is entirely overlooked, so greatly does the cyst development dominate the picture.

In the case of parasitic cysts, the subdural space should be well walled off with iodoform gauze, as in the case of abscess drainage, and the wound and cyst cavity should then be irrigated with some antiseptic solution, e. g., bichloride 1 :2000, before the wound is closed. Macewen[32] uses one per cent. carbolic acid, also powdered iodoform.

2. *Tuberculoma* should be treated, as a rule, as a tumor. When possible, the whole mass should be dissected out into normal tissue and the wound washed out with an antiseptic, e. g., carbolic acid, ½ per cent., before closing it.

If this is not practicable, owing to size or location of the tumor, or the condition of the patient, the mass may be scraped out with a sharp spoon, irrigated with carbolic lotion, packed with iodoform gauze and allowed to close by granulation. It is, of course, just as necessary to pack off the subdural space in such a case as for abscess or parasitic cysts.

3. *Syphiloma* is attacked like tuberculoma and excised. Drainage afterward is less important than with tuberculoma, but specific treatment must be continued during convalescence, and until all symptoms (even the Wassermann reaction) have disappeared. I have always used Hg and KI for specific treatment, but recent reports in the literature make it appear that the Ehrlich-Hata "606" is likely to supplant older methods.

Temporary decompression alone of syphilitic tumors is of great value sometimes in saving the eyesight when the action of specific treatment is slower than usual. (H. Cushing.[33])

4. *Vascular tumors,* when excised, require very careful hemostasis. When lying cortically, all the large veins and arteries running to the tumor must be doubly ligated and the vessels cut between the ligatures. When possible, the excision should be done through the surrounding healthy tissue, proceeding very carefully and bluntly, in order to seize all vessels before dividing them.

Vessels which do not enter the tumor should be saved wherever possible, to avoid subsequent encephalomalacia in the neighborhood of the operation site. Ligatures should be of fine catgut and gently tied, since the vessels are delicate and easily torn. Tamponade and finger pressure must be largely relied upon to stop hemorrhage that forceps and ligatures will not control.

5. *Capsulated tumors,* if benign, should be shelled out of the capsule, using the finger-tip as far as possible to peel them out. Small remnants may be removed with the curette.

Malignant tumors, when capsulated, should be removed with the capsule. The knife and Kocher director are more useful than the finger. More attention must be paid to avoiding hemorrhage and saving all possible vessels than in the case of the intracapsular removal.

---

[32]Macewen. *Pyogenic Infective Diseases of the Brain & Spinal Cord.* 1893, p. 317.

[33]Bordley and Cushing. Observations on Choked Disc, *Jour. A. M. A.*, Jan. 30, 1909, LII, No. 5, p. 357.

6. *Subcortical tumors.* When a tumor with definite localizing symptoms is not found on opening the dura, it becomes necessary to make an exploratory incision into the cortex. Some local enlargement of cortical veins, local flattening of gyri, obliteration of sulci, diminished or absent pulsation, some slight local abnormality of color and resistance on palpation may point to the spot to incise, or all these indications may be absent.

When working over the sensori-motor area, electrical stimulation may be used as an additional guide to localization.

It is, however, in these cases often necessary to incise more or less blindly and in doing so the following rules are helpful.

1. Always make the incision on the convexity of the convolutions, near their center, and not in the sulci or near them, for in the latter location lie the blood vessels. 2. Make the incision parallel in direction with the long diameter of the gyrus. There will then, as a rule, be fewer nerve fibers cut than otherwise, and any blood vessels severed will usually be small, and such an incision may be enlarged with less damage to the cortex than a transverse one. 3. Spread the edges of the incision gently with thin, smooth, metal retractors and extend it gradually inward. The finger-tip, protected, of course, by a rubber glove, may also be inserted in the opening, the better to feel tumor resistance. 4. Make the incision as small as possible to avoid cutting nerve fibers unnecessarily, and cause as little trauma as possible to its edges with finger and retractors. If no pathological changes are found, do not consume time in useless manipulation and search. Make another incision at the next most likely spot, or close the wound and transform the operation into a decompressive one. The pressure symptoms will then be relieved and at a later period localizing symptoms may develop which will admit of a subsequent successful attack.

Unless the localizing symptoms before operation were very definite, there is little use of prolonging an exploratory operation after the first cortical incision or two have been made. The results of further incision are then not likely to compensate for the injury done the cortical cells and fibers.

In operative and exploratory procedures on the cerebellum, cerebello-pontine angle, floor of the posterior fossa and vicinity, there is especially great danger of *shock, collapse and respiratory failure* from pressure on the medullary and, to a less extent, on the pontine centers.

Cushing's bilateral decompression of the cerebellum, in that it allows free dislocation of the cerebellum and permits the operator to see just what he is doing, is a great help in avoidance of such undue local pressure, and in many cases where this method of attack is used the operation may be completed at one sitting.

It is, however, at present, more usual to do a *two-step operation*, where removal of the tumor is contemplated.

At the first sitting the bone window is cut out and the dura exposed. The skin and muscle are then sewed back in place and the patient put to bed to recuperate.

A week to ten days later, if the patient's condition permit, the skin stitches are removed, the flap turned back and the dura opened,

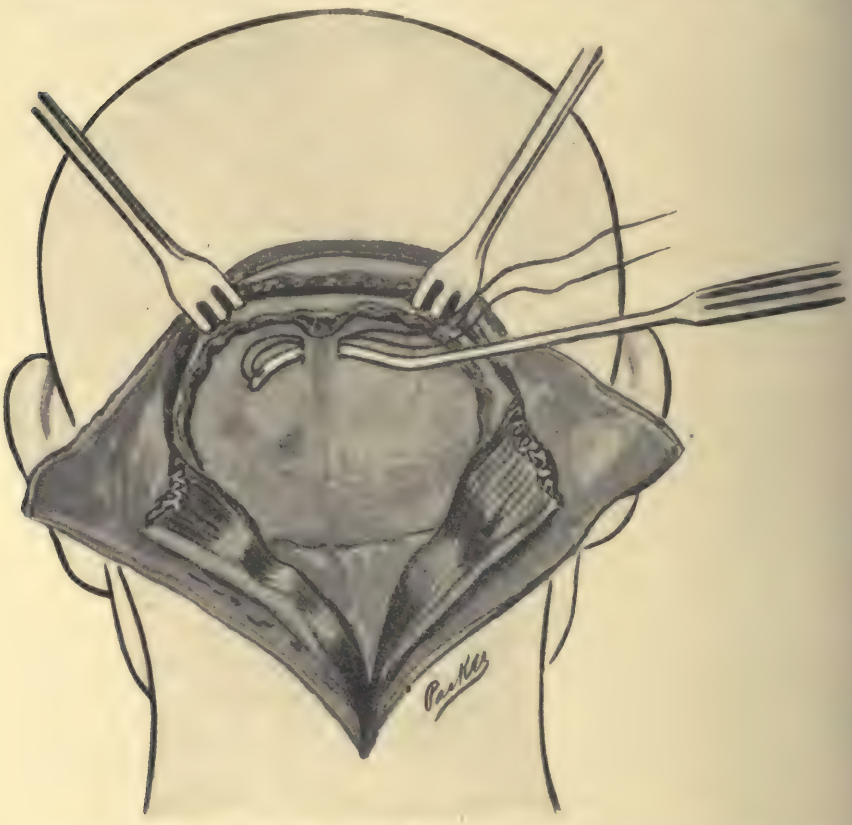


Fig. 942.

Method of Ligating the Occipital Sinus and the Overlying Strip of Dura, when it is necessary to carry the dural incision across the mid-line.

preferably as a flap, after careful isolation of the occipital and transverse sinuses and usually double ligation of the former. The second step may be done under local anesthesia, when desired, or even without any anesthetic at all.[34]

---

[34]Cushing and Thomas. Removal of a Subcortical Cystic Tumor at a Second Stage Operation without Anesthesia. *Jour. A. M. A.*, March 14, 1908, Vol. L, p. 847.

Krause. *Hirn Chirurgie*, 1908, p. 99.

Then the exploration and tumor excision are completed, hemorrhage stopped and the dura flap sewed in place with catgut, unless subsequent decompression be desired owing to inability to remove the entire tumor. In this event the dura is left unsutured, the skin and muscle flap stitched back in place and tincture of benzoin and silver foil, or collodion, applied to the suture line of the skin, after which the usual dressings are applied.

Fig. 943.

Serous Cyst of the Cerebellum, near the Cerebello-Pontine Angle. (Author's Case).

As an example of the results obtainable by modern cranial surgery, I should like to cite the case of a patient (of Drs. O. W. McMichael and Alfred Murray) operated on by me January 27 and February 3, 1910, using the suboccipital procedure of Cushing in two stages. The diagnosis before operation was left cerebello-pontine angle tumor. At the operation a cyst containing serous fluid was found at the assigned location, but imbedded in the cerebellar sub-

stance. It was drained and its wall curetted. There was immediate cessation of pressure symptoms dating from the performance of the first stage of the operation.

Headache and vomiting disappeared and patient stated that he thought his vision was better, though ophthalmoscopic examination showed only a trifling change.

The improvement in vision after the completion of the second step was very marked, as shown by the charts and ophthalmoscopic examination.

When we consider in this case the man's fate without operation, his life slowly blotted out, tortured with pains (only partially controlled by the continuous use of morphine) the onset of blindness, deafness, imbecility, we must recognize the great boon that brain surgery has been to him. In contrast with this picture the patient's eyesight is preserved, though not quite *in toto*, owing to partial atrophy consequent to his choked discs; and we believe that an earlier operation would have shown still greater improvement. He is free from pain, eats well, vomits no more and has not the morphine habit. He is still deaf in the left ear, but hears all ordinary conversation with the right. His intelligence is undiminished and he is able to attend to most of his routine duties and continue his business.

TECHNIQUE OF OPERATIONS ON THE HYPOPHYSIS CEREBRI.

The operative technique dealing with tumors of the hypophysis has been a matter of gradual development. As late as 1905, Cushing,[35] was led to say that in the near future operations on the hypophysis cerebri might be carried to a successful issue.

A brief review of the steps that have led to our present technique may be of interest in tracing the progress of this most recent triumph of modern surgery.

Of the operations proposed, two principal routes have been chosen to reach the hypophysis; first, the intracranial; second, the extracranial or trans-sphenoidal. Through the former the hypophysis may be reached either by *way of the anterior* or the middle cranial fossa. The major part of the operation may be accomplished by working outside of the dura, or the dura may be opened in the beginning and the work done entirely within its cavity.

The possibility of reaching the hypophysis through the middle cranial fossa was first proposed by Caton and Paul,[36] but was not

[35]Cushing. The Special Field of Neurological Surgery. *Johns Hopkins Hosp. Bull.*, March, 1905, p. 77.

[36]Caton and Paul. Case of Acromegaly Treated by Operation. *British Medical Journal*, Dec. 30, 1893, p. 1421.

carried out by them. Horsley is generally quoted as following this route.

Stumme[37] quotes a personal communication from Petrien, in which he credits Dahlgren with an operation conducted through the middle fossa. In this the dura was opened and the hypophysis reached by retracting the brain. Nothing is said of the details of the operation or of the result.

Krause[38] suggested what appears to be the most rational intracranial method of reaching the hypophysis. He proposed to open the cranial cavity by an osteoplastic resection of the frontal bone and to proceed, extradurally, through the anterior cranial fossa until the lesser wing of the sphenoid is reached, and then to open the dura and remove the tumor by means of a small, hook-shaped knife devised for that purpose. Krause, from his experience gained only by operation on the cadaver, believed that by following this extradural route all or most of the obstacles which other operators had encountered would be eliminated.

Borchard[39] attempted to remove a tumor of the hypophysis by the Krause method, and was forced to abandon it because of the hemorrhage. Later, he operated successfully on the same patient by the trans-sphenoidal route, as practised by Schloffer.

Killiani,[40] in discussing tumors of the chiasm, suggests an operation which is similar to that of Krause, excepting that the dura is opened immediately after entering the cranial cavity. The longitudinal sinus is ligated, the frontal lobe lifted from the base of the skull, and the tumor attacked above the chiasm and the transverse sinus by means of a sharp spoon.

Silbermark[41] suggests a temporal intracranial method similar to that employed by Paulesco and Cushing,[42] in their experimental work on dogs. This consists in a bilateral craniectomy, the counter opening being made to permit of the temporal lobe being dislocated without the risk of serious compression. The operation proposed by Silbermark and by him performed on the cadaver has never been tried on the living subject.

The relative merit of the intracranial method, as compared to

---

[37] Stumme. Akromegalie und Hypophyse. *Arch. f. Klin. Chir.*, Bd. 87, 1908, p. 437.

[38] Krause. Freilegung der Hypophyse. *Die Deutsch. Klin.*, Bd. 8, 1901, p. 1004.

[39] Borchard. *Zentlb. f. Chir.*, 1908.

[40] Killiani. Tumors of the Chiasm; How Reached by Operation. *Annals of Surgery*, 1904, Vol. 40, p. 35.

[41] Silbermark. Die intrakranielle Exstirpation der Hypophyse. *Wien. Klin. Woch.*, No. 13, 1910, Vol. XXIII, p. 467.

[42] Cushing. Partial Hypophysectomy for Acromegaly. *Annals of Surgery*, Dec., 1909, Vol. 50, P. 1002.

the trans-sphenoidal, is still a matter for discussion. Most operators have chosen the latter. Up to the present time no one has successfully removed a tumor of the hypophysis through the anterior intracranial route.

Fig. 944.

Removal of Hypophysis Tumor by way of the Oro-nasal Route. The upper Lip Retracted, showing the Initial Incision through the Mucous Membrane.

The temporal route, by way of the middle fossa, has been followed by Dahlgren and Horsley.

The anatomical structures that come in relation to the opera-

tive field are many and of great importance. Injury to the large venous sinuses, if not a serious menace to the life of the patient, would at least delay the operation and would probably preclude the possibility of completing the operation in one sitting. In the intracranial operation, aside from the danger of injury to the important blood vessels and nerves, retraction of the brain sufficient to expose the hypophysis is likely to be followed by softening or necrosis, as a result of the trauma and interference with its blood supply.

The lateral intracranial operation has been employed by Cushing in over one hundred experiments on dogs. While by this method the canine hypophysis is readily exposed, Cushing is of the opinion that it is not practicable in operations on the human, excepting possibly in benign cysts of the gland that project into the infundibular region. In cases where the growth occupies the sella turcica, it would be impossible to reach it excepting by the trans-sphenoidal route.

The first to suggest the *trans-sphenoidal extracranial operation* was Koenig,[43] in 1898. His procedure was identical with the oro-nasal operation practised by Friedman and Maas on animals, and by Gussenbauer for the removal of naso-pharyngeal growth. It consists in separating the muco-periosteal covering from the palatal process of the superior maxilla, after which the process is chiseled away and the superior maxilla split and the lateral halves retracted. The septum and vomer are removed with the other structures of the nose that may obscure the view of the operator. The sphenoid cells are opened and their posterior walls chiseled away, bringing into view the hypophysis.

A similar operation has been proposed by Loewe.[44] The nose is split by means of a long incision to one side of the median line, the maxillæ are separated, the inner walls of the maxillary sinus are removed, from the canine fossa upwards, and the septum divided back to the vomer, which is removed and the sinuses entered by chiseling away their anterior walls. The sella is reached through the sphenoid cells.

It will be seen that the bucco-nasal route of Koenig and the operation of Loewe are in reality quite similar in the essential features to the later inferior nasal operations. The strongest objections urged against both of these procedures is that they are unnecessarily severe and disfiguring. They have, however, the advantage of offering the most direct route to the sphenoid cells, with least risk of entering the cranial cavity anterior to the sella.

---

[43] Koenig. *Berl. Klin. Woch.*, 1900, p. 46.
[44] Loewe. Chirurgie der Nase, *Zeitsch. f. Augenheilk.*, Bd. XIX, 1905, p. 5.

The first to suggest the *superior nasal route* was Giordano.[45] This method, as practised by him on the cadaver, consists in an osteoplastic resection of the anterior wall of the frontal sinuses and the nose. These structures are turned down, the ethmoid cells opened and their walls removed. The cells of the sphenoid are then opened and the hypophysis reached through an opening in the anterior wall of the sella.

The operation of Giordano has been followed, though slightly modified, at times by all who have chosen the superior nasal route in operating on the hypophysis.

Schloffer,[46] in 1907, successfully removed a tumor of the hypophysis by a similar method. An incision was made above and to the left of the nose; the whole nose turned down and to the right; excision of all of the turbinate bodies, septum, inner wall of the orbit nearly to the optic foramen; removal of the inner wall of the left maxillary sinus and part of the left nasal process of the superior maxilla; opening of the ethmoid cells and extirpation of their walls; opening of the sphenoidal cells through which the sella is broken down. The tumor was recognized as a *pulsating mass*, projecting through the opening in the sphenoid, and was curetted with a sharp spoon. The patient survived two and one-half months. Autopsy showed that only about one-sixth of the growth remained.

The operation proposed by Moskowicz and Tandler[47] differs slightly from that practised by Schloffer. The inner wall of the orbit and that of the antrum are not disturbed. They also recommend that the operation be performed in two steps. The first takes the operator to the posterior wall of the sphenoid sinus, which is permitted to remain intact. A pedunculated flap of skin is then turned down from the forehead, so that the end comes to lie on the sinus wall. At the second step the posterior wall of the sinus is broken down, and the end of the skin flap pressed into the cavity remaining after opening the sella and removing the tumor. This is held in place by a tampon. The skin flap is so placed, in order to lessen the dangers of infection. This step seems to be of questionable value. It would appear to enhance rather than minimize the risk of infection of the meninges.

v. Eiselsberg[48] in the three cases published followed the superior nasal route. The incision described differs slightly from that employed by Schloffer, in that a vertical incision along the median

[45]Giordano. Cited by Schloffer.
[46]Schloffer. Zur Frageder Hypophyse-Operation. *Beitrage zur Klin. Chir.*, Bd. 50, 1906, p. 767.
[47]Moskowicz and Tandler. *Wien. Klin. Woch.*, 1907, p. 714.
[48]v. Eiselsberg. *Wien. Klin. Woch.*, 1907, p. 1341; 1908, p. 1115.

line of the forehead meets a curved incision above the root of the nose. The nose, with the anterior wall of the frontal sinus, is reflected downwards and to the right. The septum is divided and the

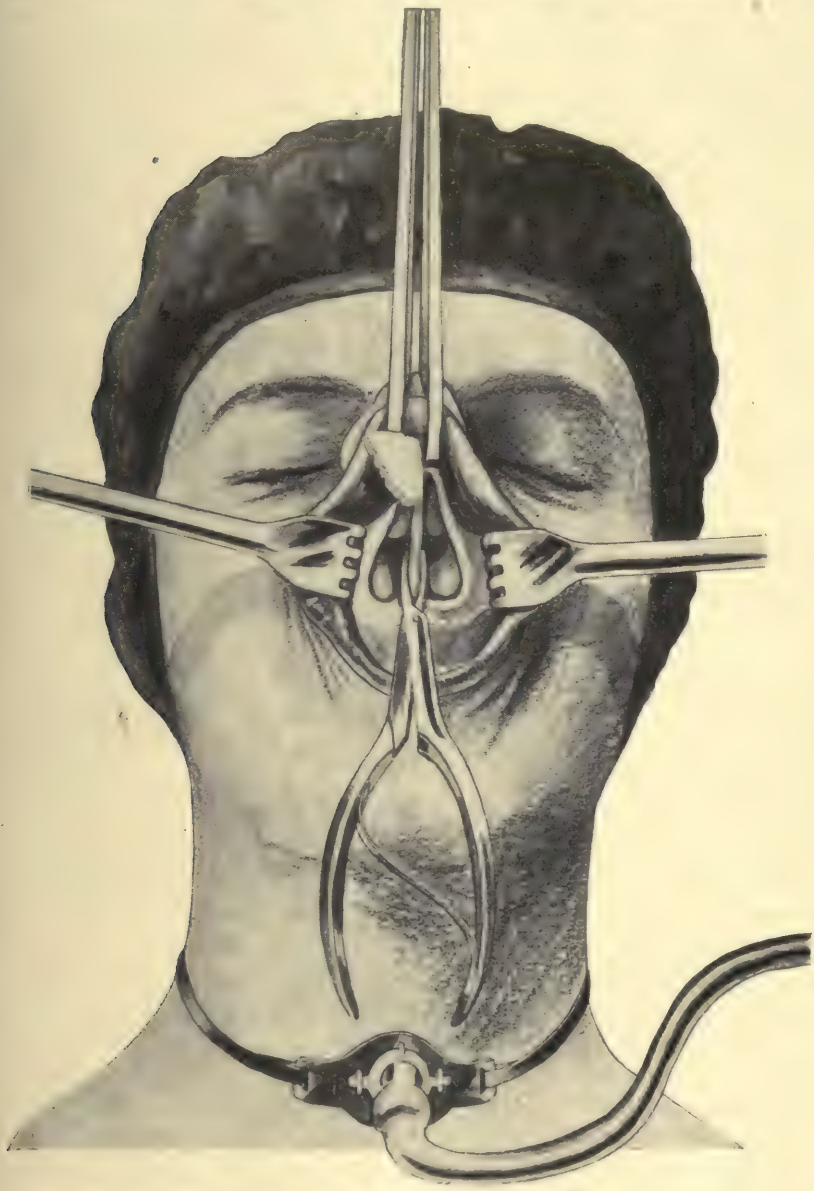


Fig. 945.

Removal of Hypophysis Tumor by way of the Oro-nasal Route. Second Stage. The Septum is divided under the Retracted Lip and through the Mouth. The Turbinals and Vomer present through the Nasal Cavity.

superior turbinals removed. The vomer is removed piece by piece up to its root. After lifting the periosteum from the anterior wall of the sphenoid, the sinuses are opened by chiseling into them. The tumor is then exposed by removing their posterior walls.

Borchard at first attempted the removal of a hypophysis tumor by a frontal intracranial operation. This failed on account of profuse hemorrhage making it impossible to locate the hypophysis. Later, through the superior nasal route, as practised by Schloffer, he succeeded in exposing the tumor and removing a part of it.

Stumme, in 1908, describes an operation performed by Hochenegg upon a patient suffering from acromegaly, with other symptoms of pituitary tumor. The technique followed was similar to that of v. Eiselsberg. The anesthetic employed was Billroth's mixture, preliminary to the administration of which the post-nares were tamponed with gauze. After turning down the nose, an osteoplastic flap containing the anterior walls of the frontal sinuses was reflected upwards. The septum and the entire contents of the nose, including all of the turbinals, were removed. The inner wall of the antrum and orbit was left intact. The sphenoidal sinuses were opened by means of a chisel and, later, their posterior walls, exposing the tumor, which was removed by a spoon-shaped instrument. The cavity was packed with gauze and the nose replaced and sutured.

Cushing has operated on three cases. In the first, an acromegalic, he employed the supranasal operation, similar in detail to that of Hochenegg, excepting that the anterior walls of the frontal sinus were turned down with the nose. Preliminary tracheotomy was performed; the nares plugged with a sea sponge. The Rose position was maintained during the operation, as in Hochenegg's case. After rongeuring away the walls of the ethmoid cells, a narrow mesial channel (two centimeters wide), was chiseled below the ethmoid roof and carried back to the sphenoid cells. The anterior walls of the cells were then broken down and the median projection of the sella into the cells was located. The thin, bony wall of the sella was then clipped away, exposing a pocket of dura enclosing the gland. This was incised longitudinally, and half of the exposed gland removed.

In November, 1909, Kanavel,[49] of Chicago, published a method of approach in removing tumors of the hypophysis that he termed the infranasal route. At the time of publication of the paper, the operation had not been performed upon the living subject by Kanavel. After a series of experiments on the cadaver and a trial of the vari-

[49] **Kanavel.** *Jour. Am. Med. Assoc.*, Nov. 20, 1909, Vol. LIII, No. 21, p. 1704.

ous operative procedures recommended by others, he came to the conclusion that the hypophysis could be best reached by turning up the nose and proceeding directly to the sphenoid cells, without interfering with the ethmoid, after removing the turbinales, deflecting the septum, and cutting away the vomer.

Recently, West,[50] of Baltimore, recommends practically the same procedure, excepting that the operation be conducted through the nose. West recommends that the operation be performed in two stages, and that the preliminary operation of removal of the middle and inferior turbinales be done under local anesthesia. The septum and vomer are removed at the second operation, after which the cells are opened and the sella chiseled through.

The method that I have adopted and carried out successfully in a patient operated upon in July, 1909, and recorded in the *Trans. of the Am. Surg. Assoc.*, 1910, is as follows:

Pads of sterile cotton moistened in boric acid solution are held over both closed eyes while the face and neck are washed with soap and water on fluffed gauze and then with alcohol and bichloride, 1:1,000.

The patient is anesthetized with ether by the usual drop method, the anesthetist having previously scrubbed up, put on sterile gloves and using a sterile mask. As soon as the patient is asleep, a high tracheotomy is done and a Trendelenburg balloon canula inserted. Chloroform is now used to continue the anesthesia.

Aditus ad laryngem, pharynx and mouth are now tightly packed with gauze strips.

The upper lip is raised and an incision is made in its mucous membrane about five-sixths of an inch from the muco-cutaneous junction and parallel to the alveolar process. The soft tissues are freed and the nose gradually drawn up with retractors, the nasal mucous membrane incised and the nasal cavity opened.

The cartilaginous nasal septum is divided with bone-cutting forceps flush with the nasal floor and displaced upwards and laterally. The lower and middle turbinals, the vomer and the perpendicular plate of the ethmoid are removed with scissors and forceps. We thus have formed a cylindric cavity of the width of the nose and about four inches deep, reaching to the anterior wall of the sphenoid sinus. This cavity is then packed tightly with adrenalin gauze for a few minutes until oozing has stopped and the mucous membrane of the nose and anterior surface of the sphenoid sinuses are well blanched.

Upon removing this tampon the anterior and then the posterior

[50] West. *Jour. Am. Med. Assoc.*, April 2, 1910, Vol. LIV, No. 14, p. 1132.

wall of the sphenoid sinus are bitten through with the Hajek punch and the sella turcica with the enclosed hypophysis lies exposed. The tumor is now removed piecemeal with a dull curette, forceps and

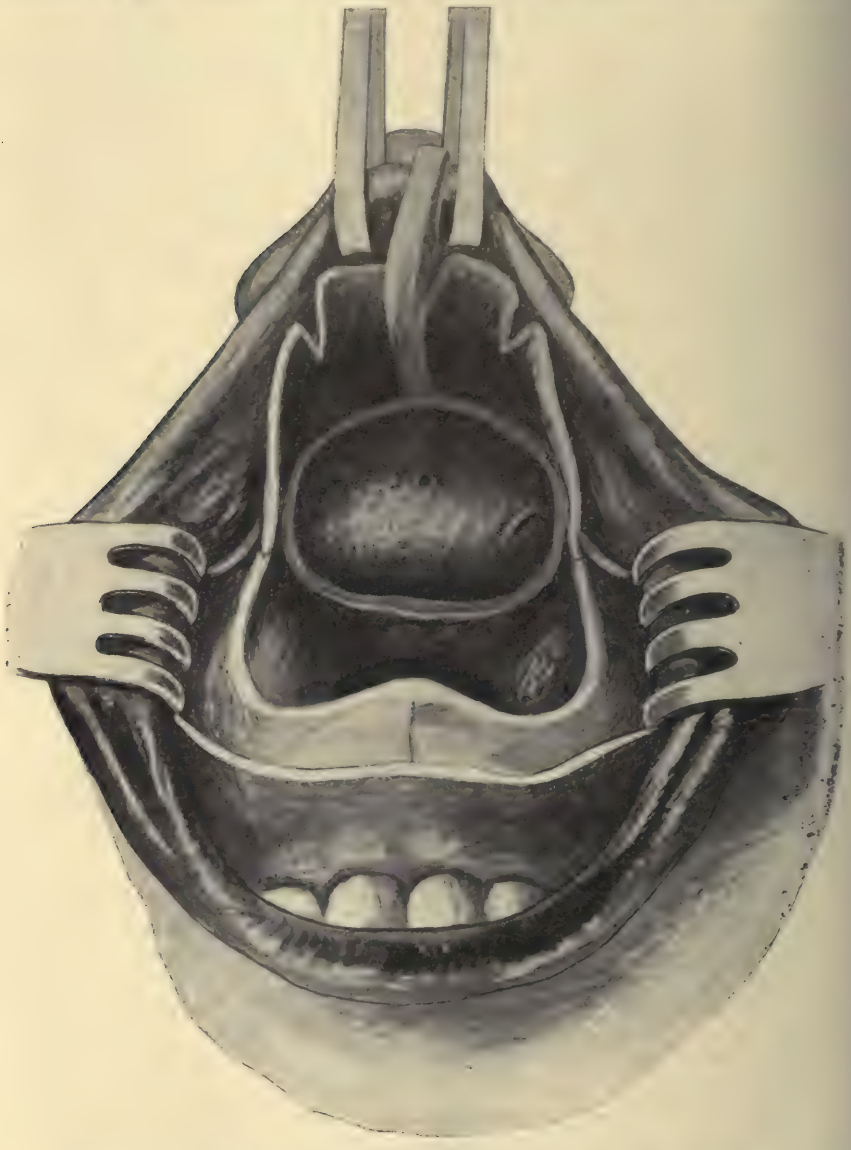


Fig. 946.

Removal of Hypophysis Tumor by way of the Oro-nasal Route. Third Stage. The Nose and Upper Lip are retracted Upwards over the Forehead after Dividing the Septum, freeing the soft Parts from the Superior Maxilla. Turbinals, Vomer and all Obstructing Tissues Removed down to the Anterior Sphenoid Cells.

scissors. Any subsequent hemorrhage is controlled by tamponing with adrenalin gauze.

When the tumor tissue has been removed and the hemorrhage controlled, the whole cavity is flushed out with normal salt solution and the sella and entire nasal cavity are packed with iodoform gauze saturated with tincture of benzoin.

The septum is then sutured back and the mucous membrane of the mouth reunited by suture and the Trendelenburg canula replaced with a tracheotomy tube. The patient is then put to bed in a semi-recumbent position. As soon as he regains consciousness the packing is removed from throat and mouth. The tracheotomy tube is removed on the following day and the wound closed by suture and dressing.

Fig. 947.

Photograph of a Patient (H. R.) Two Months After Removal of a Tumor of the Hypophysis through the Oro-Nasal Route.

The nasal packing is allowed to remain in place for two or three days unless the patient's temperature rises above 100° F. Then it is removed and the nose flushed out daily thereafter with normal saline solution before the packing is renewed. After a week the packing is dispensed with and the saline irrigation continued as long as the patient remains in the hospital.

The accompanying diagrams give a very fair idea of the differ-

ent steps in the operation and the photograph shows the faultless cosmetic result obtained, which is all the more striking when compared with the results obtained by all the previous methods in which the external incision is used.

DANGERS AND COMPLICATIONS OF INTRACRANIAL OPERATIONS; THEIR AVOIDANCE AND TREATMENT.

In general, these dangers and complications are not many and are relatively easily avoided, as a rule, if borne in mind during operative proceedings. Most of them have been already touched upon during the previous general discussion of the subject of operations.

A. Dangers at the Time of Operation.

(1) *Hemorrhage* has already been discussed at sufficient length under operative technic. It may at times be annoying, but never dangerous, with our modern means of hemostasis—tourniquet, Kocher forceps, preliminary sutures, pressure, tamponade, Horsley's wax, muscle tissue, etc. (2) *Shock, collapse and sudden respiratory failure* are now much less frequent since the introduction of the principle of cerebral dislocation and the two-step operation, and the recognition of the fact that these alarming complications are due to sudden changes of pressure, chiefly over-pressure on the medullary centers.

Though prevention is the main factor in their treatment, I consider of great importance the intravenous administration of normal salt solution, with the addition of 2 cc. of 1:1,000 adrenalin solution to the litre in amounts up to two to four litres. Hypodermoclysis is also of value, but is too slow for the cases of sudden collapse. The use of the reversed Trendelenburg position is also important. For the operation itself the head and shoulders are kept high as long as the patient's condition is good, but as soon as collapse threatens they should be promptly lowered.

I have at times considered the advisability of laying bare the internal saphenous vein before starting the cranial operation in cases in which I had reason to anticipate collapse, so that salt solution might be given in large amounts and without a moment's delay. As yet I have not put this plan into practice.

(3) *Infection.* Septic infection is practically never introduced from without in the modern, aseptic operation. It can occur only when we have to deal with tissues already infected, e. g., subdural abscess, cerebral abscess and purulent meningitis, the last being rarely attacked by operative procedure, or occurring with wounds of the cranial vault.

The avoidance of infection in the treatment of intracranial abscess has been discussed already under the subject of brain abscess. It consists in (a) puncturing the brain to locate the abscess only after the dura has been opened and the subdural space walled off with several layers of iodoform gauze; (b) thorough opening up of the abscess; (c) irrigation followed by renewal of the outer layers of gauze, and (d) drainage puncture through the galea flap directly over the abscess opening.

(4) Danger of *infection of the meninges* and brain tissue from parasitic cysts and malignant tumors is to be combated in the same way as in the case of intracranial abscesses, except that in the former case removal of the source of infection by excision into healthy tissue may at times enable us to get rid of the entire focus of infection at one stroke.

(5) *Dangers from Anesthesia.* It goes without saying that in this field of surgery, if in any, the assistance of an experienced anesthetist is required. The awkward, strained position which the anesthetist must assume in operations on the posterior half of the cranium, enshrouded in a sheet and breathing vitiated air saturated with ether, with irrigating fluids trickling down on him at intervals, makes his duties onerous. He must administer the anesthetic to a point above his head, keep irrigating fluids out of the patient's mouth, nose and eyes, hold up the mask continuously and occasionally, when another assistant is not available, watch respiration and heart beats through a Bowles' stethoscope fastened to the patient.[51] In these exacting cases I feel that such good results as I have obtained have been due in no small measure to the experience and skill of my anesthetists at St. Luke's Hospital.

Shock and collapse are to be avoided by care not only on the operator's part, but just as much by careful watchfulness, backed by experience on the part of the anesthetist.

To prevent vomiting, washing out of the stomach just before the operation and just after the patient has regained consciousness is the most efficacious measure, though not any too agreeable to the patient.

B. POST-OPERATIVE DANGERS AND COMPLICATIONS.

(a) *Collapse*, though most prone to occur in the late stages of the operative procedures, may appear at any time, even several days after the operation; but the danger is greatest in the first twenty-four to thirty-six hours after operation.

[51] Cushing. *Interstate Med. Jour.*, St. Louis, 1908, Vol. XV, No. 2; also, *Jour. Am. Med. Assoc.*, Jan. 16, 1909, p. 184.

The remedial measures are the same as when it occurs during the operation, except that, inasmuch as the collapse does not appear in as urgent a fashion as in the latter case, it allows the surgeon more leeway in which to act. If, in addition to collapse, there are pressure symptoms, there is probably present a (b) *post-operative hemorrhage,* which, if extensive or progressive, must be treated by reopening the wound, scraping and irrigating away the clotted blood and ligating or tamponing the bleeding point.

Hemorrhage is best prevented. Careful hemostasis during the operation, ligation of all bleeding points and tamponing for a day or two for any oozing beyond the slightest amount, will save the surgeon worry and his patient a second operation.

(c) *Edema and softening of the brain* (encephalomalacia) may be the consequence of a neglected hemorrhage, or it may arise after any trauma of the brain substance. It varies, as a rule, directly with the amount of injury to which the brain tissue has been subjected during the operation, and is commonly, most severe after removal of subcortical or extensive tumors and cysts, in the treatment of which it is often necessary to interrupt the continuity of many nerve fibers and blood vessels in brain tissue whose vitality has already been lowered by the long-continued presence of the tumor.

The severer grades of the edema which may cause prolapsus or even fungus cerebri and extensive pareses and paralyses are fortunately rare, for they may be rapidly fatal.

Slight edema associated with a superficial necrosis of the brain tissue surrounding the tumor, and a small discharge of broken-down brain tissue on the third or fourth day following operation, without other symptoms of moment, is less infrequent and has no particular significance.

(d) *Prolapsus and fungus cerebri.* The former complication is common and is to be expected wherever a decompressive operation is done for increased intracranial tension at a spot where the galea is not reinforced by muscle, *i. e.,* outside the subtemporal and suboccipital regions. It is at that result that we aim. It has, as a rule, no untoward symptoms, unless excessive, and can, until it reaches a considerable amount, be concealed by hair dressing, particularly in women.

Fungus cerebri may arise where (1) intracranial pressure, already excessive at the time of operation, is still further increased by post-operative edema; or where (2) a decompressive operation is done directly over a rapidly-growing tumor, especially in an area not covered by muscle; or where (3) tamponade must be continued for

several days, on account of hemorrhage or suppuration, and where intracranial pressure at the same time is excessive.

The *treatment* is, first and foremost, prevention. Tamponade as a hemostatic measure must be avoided as far as possible in cases of increased tension. When tamponing is unavoidable, the protecting bandage over the skin flap should be applied tightly, to re-enforce the skin approximation. The packing should be removed and skin stitches inserted at the earliest advisable moment, within thirty-six or forty-eight hours, if possible.

Abscess drainage should be led directly through a puncture wound in the skin flap, so that the suture line is left undisturbed. This drain should be tubular, not bulky, therefore allowing much less chance for subsequent prolapse than does tamponade. The tamponade of the subdural space in abscess is the chief source of danger from prolapse in such cases, since it can only be removed gradually, as we feel certain that adhesions have formed that protect the space.

Decompressive trepanation should not be done directly over a tumor, particularly a rapidly-growing one. At times this procedure is unavoidable, because we cut down on the tumor site, hoping to be able to remove the tumor, and, finding it impossible to eradicate, we are forced to turn the operation into a decompression in order to relieve symptoms. But if we have an osteoplastic flap of such shape that it may be returned accurately in one piece to the cranial defect, and if the patient's condition is sufficiently good to allow of a second decompressive trephining at one of the sites of election, *i. e.*, subtemporal or suboccipital (a combination of circumstances which too frequently does not obtain), we may observe the rule at the expense of prolonging the operation and increasing shock. In such cases a point in technique of considerable value is to make the opening in the dura in the shape of a flap, the base of which is placed opposite the base of the galea flap, so that there may be a certain amount of overlapping, which will keep the prolapse well covered when it does occur, and also to a certain extent protect the skin suture-line while it is healing.

The exertion of pressure over the skin flap is in general to be carefully avoided, but becomes a necessity when prolapse is considerable and increasing and threatening to result in a fungus.

When a fungus has actually formed (a) it must be kept scrupulously clean, fresh dressing being applied daily with careful asepsis; (b) pressure must be applied by the dressing in an attempt to reduce the swelling or at least keep it within bounds; (c) tension sutures (silkworm gut) may be applied to draw the skin flaps together; or

(d) an attempt may be made at a plastic closure by using a galea flap, but the success of this latter procedure is always doubtful in rapidly developing fungus. Lastly, (e) excision of the fungus may be practised to keep it within bounds or from becoming infected. It is remarkable what large areas of the "silent regions" of the brain may be removed in this way without producing any appreciable symptom. In cases of doubt as to whether to excise or not to excise it is well to remember that it is much better to cut away such a portion than to have it slough away, with the consequent dangers of local and meningeal infection.

(f) *Escape of cerebrospinal fluid* in considerable amount through the wound is not at all unusual. If it does not occur through the wound itself, it is very apt to trickle through a needle puncture somewhere along the line of suture, and, once started, it may be very persistent. For this reason I make it a practice to remove stitches as early as possible in my cranial operations, usually from the fifth to the seventh day, if the wound is in good condition, and apply a snug dressing for a few days after the stitches have been removed, and usually, also, collodion and tincture of benzoin on gauze to the suture line.

As long as liquor trickles anywhere through the wound, careful aseptic daily dressing must be continued, and during the day the outer dressings must be renewed by the nurse or interne as often as they are saturated with the discharge.

The sealing of the line of suture with collodion at the operation and the subsequent daily dressing with tincture of benzoin or collodion on gauze strips is, I believe, of considerable assistance in preventing these small leaks.

Where a leak has already occurred, it is not much use to try to put a stitch through it. New portals of exit are too apt to form through the needle punctures.

I usually cauterize these small openings daily with the silver nitrate stick and then apply gauze strips saturated with tincture of benzoin, with compression by the dressing or adhesive strips over that. Practically all these small fistulæ yield to this treatment in the course of a week or two.

Occasionally the closure of one of the more obstinate and persistent of these little fistulæ may be accompanied by renewed symptoms of intracranial pressure of low degree, headache, malaise, nausea, etc. A reopening of the fistula is thereby necessitated, which is allowed to persist for a few weeks more, and is then closed again and allowed to remain closed as long as the patient remains free from pressure symptoms.

(g) *Post-operative fever* may be considerable after intracranial operations without being due to sepsis. Whether these higher temperatures are "absorption fevers," due to taking up by the circulation of the products of broken-down brain tissue, or to pressure on or trauma to some central "heat center," it is difficult to say. At any rate, a temperature of 103° to 104° F. for a day or two after a clean operation does not mean that the wound must be reopened, or that the patient is necessarily in a serious condition. Temperatures of 101° to 102° are not infrequent during the first few days following operations.

Necrosis of the bone flap after osteoplastic operations is occasionally a factor, probably, in these post-operative rises in temperature, though by itself it is not capable of producing anything above a low grade of fever.

Necrosis *in toto* or in *magna parte* of the bone flap is unusual and can only occur when the bone is widely denuded of its periosteum, or when in the absence of claw forceps to hold the bone-periosteal flap to the galea, manipulations of the tissues causes separation of the galea from the bone, something that is likely to happen to any operator unless his assistants have been trained to look out for and guard against it; or where suppuration is present.

More frequent, but still unusual, is a slight discharge of particles of bone sand where edges of the bone flap have undergone a slight necrosis.

But, in general, bone necrosis is a very slight danger, and it has been known for many years that isolated bone fragments may be safely reimplanted where infection and undue pressure are absent.

BRAIN PUNCTURE.

While our present conception of the technic and clinical value of brain puncture dates from the publication of the thorough experimental and clinical study of Neisser and Pollock,[52] yet Middeldorpf,[53] in 1856, had suggested the procedure on the basis of experimental evidence. Maas[54] not long afterwards insisted on its use as a preliminary step in the operative treatment of brain abscess.

In this country Souchon,[55] in 1889, developed a technic from ani-

---

[52]Neisser and Pollock. Die Hirn Punktion. *Mitth. a. d. Grenzg. d. Med. u. Chir.*, Vol. 13, 1904, p. 807.

[53]Middeldorpf. Ueberlick ueber die Akidopeirastik. *Günzburg's Ztschr. f. Klin. Med.*, Breslau, 1856, Vol. 7.

[54]Maas. Zŭr Kasŭistik ŭ. Therapie d. Gehirnabscesse nach eigenen Erfahrungen. *Berl. Kl. Woch.*, Vol. VI, No. 14, 1869, p. 127.

[55]Souchon. On the Drilling of Capillary Holes through the Skull for Exploring the Brain with Needle and Syringe. *New Orleans Med. and Surg. Jour.*, 1889.

mal experimentation. Schmidt,[56] four years later, pointed out the surgical possibilities of the procedure, particularly in connection with the treatment of abscesses of otogenic origin.

Payr[57] a little later extended the technic to include the harpooning of brain specimens for histological examination, a procedure which has found little favor elsewhere, and justly so, on account of the very considerable dangers and relatively small benefits connected with it.

The Kocher[58] clinic, in 1899, already had a well-developed technic, which was published by Albert Kocher, and does not differ particularly from that at present in use.

One year before Neisser and Pollock published their work, Nicholas Senn[59] published a case of internal hydrocephalus, which he had treated by connecting the subcutaneous tissue of the scalp with the ventricle by means of a thin rubber drain, using at the same time elastic compression of the skull. This method of ventricle drainage was first used by G. A. Sutherland[60] and Watson Cheyne (who used folded lengths of catgut instead of rubber), and later, though published earlier, by Henle,[61] who used a gold tube.

Since the appearance of the paper of Neisser and Pollock, the method has been tried extensively and has come to occupy a permanent if rather limited field of surgical usefulness.

B. Pfeifer[62] has reported the experience of Wernicke's clinic at Halle, and F. Krause has reported his experience on a still larger material.

INDICATIONS FOR CEREBRAL PUNCTURE.

For diagnostic purposes brain puncture is at present done chiefly after the dura has been exposed by cranial resection, so that possible hemorrhage may be controlled and purulent fluid be walled off from the meningeal spaces. It is generally employed: (1) to locate subdural

---

[56]Schmidt. Zur Schädelperforation mit nachfolgender diagnostischer Gehirnpunktion. *Arch. f. Klin. Chir.*, Vol. 45, 1893, p. 586.

[57]Payr. Einige versüche ueber Explorativ-operationen am Gehirn. *Centrlbl. f. Chir.*, 1896, No. 31, Vol. 22, p. 737.

[58]Kocher. Ueber eine einfache Trepanationmethode für intracerebrale Injektionen. *Centrlbl. f. Chir.*, 1899, No. 22, p. 643.

[59]Senn. Subcutaneous Drainage in the Surgical Treatment of Hydrocephalus Internus. *The Alienist and Neurologist*, Aug., 1903, Vol. XXIV, No. 13, p. 316.

[60]Sutherland. *Pediatrics*, No. 98, 1899.

[61]Henle. Beitr. z. Path. u. Therap. d. Hydroceph. *Mitth. a. d. Grenzgeb. f. Med. und Chir.*, I, 1896, p. 26; also Ventrikeldrainage. *Ibid.*, 1897, Vol. 1, p. 264.

[62]Pfeifer. Ueber explorative Hirnpunktionen nach Schädelbohrung zur Diagnose von Hirntumoren. *Arch. f. Psych.*, Bd. XLII, Hft. 2, pp. 451 to 603. Habilitationsschrift, 1907, und *Jahrbücher f. Psych. u. Neurol.*, Bd. XXVIII, 1907, p. 323.

and epidural hematomata; (2) to locate collections of pus; (3) to locate cysts of various origins; (4) to locate and determine the character of brain tumors—a dangerous and not very reliable procedure, but still used by F. Krause.

For purposes of treatment it is used for (1) temporary and permanent drainage of the ventricles in internal hydrocephalus, acute and chronic, whatever the origin; (2) evacuation of pus and blood; (3) evacuation of fluid from meningeal space and lateral ventricles to diminish pressure before decompression or exploratory operations.

Dangers of Brain Puncture.

1. The chief danger is from *hemorrhage,* which is naturally very much less when the puncture is done in connection with a resection of the cranium, so that large veins can be avoided and any bleeding promptly seen and checked.

In the use of the puncture through a small trephine opening by the method of Neisser and Pollock, the chief danger is from injury to the *pial veins* by the point of the exploratory needle. Though normally small, in diseased conditions they are often greatly dilated and the walls are at all times very fragile and delicate.

The dural veins are injured less easily, but may give rise to very severe hemorrhage at times.

The branches of the middle meningeal artery may be injured during the trephining, but are more easily seen and the hemorrhage controlled by ligation.

Vascular tumors on the surface and in the tissue of the brain are still more dangerous to puncture; *e. g.,* angiomata, angiosarcomata, etc., may exist, which may easily give rise to fatal and unrecognized hemorrhage.

2. *Septic infection* is rarely likely to be carried in from without, but may easily infect meninges from a punctured abscess if the Neisser and Pollock puncture is done without walling off of the meningeal space.

3. *Tumor infection* may easily be carried into the healthy parts of the brain by the exploring needle when the tumor lies superficially and the needle, as often happens, is inserted through and beyond it.

4. *Focal symptoms* from destruction of nerve centers are avoided by not putting in needle too deeply (four inches is the limit in any direction, and five to six centimeters is usually far enough).

Pons, medulla and basal ganglia lie so deeply that there is rarely danger of striking them. Puncture in the motor area may have disagreeable after-effects, as in a case of F. Krause's, which was followed by temporary arm paralysis and severe general prostration and shock.

5. *Sudden collapse* from diminution of intravenous pressure may occur with the larger collections of blood and pus, but is especially apt to occur in the evacuation of an internal hydrocephalus. If this happens the head is lowered and the veins filled with salt solution and adrenalin. The best means of preventing this complication is to slowly evacuate the fluid.

6. Acute and fatal edema of the brain associated with great increase of intracranial pressure occasionally follows puncture of the ventricles. I have seen alarming symptoms develop in two cases operated on by me when exploration was being carried out. Repeated emptying of the lateral ventricles and stimulation restored the patient.

Technic and Location of Brain Punctures.

There are a few obvious rules to be observed which make the location of the puncture a relatively simple performance. 1. Avoid blood vessels. (a) Punctures are not made near the mid-line nor near any of the venous sinuses, for fear of wounding the larger blood vessels as well as the sinuses themselves (*i. e.*, transverse sinus, longitudinal sinus, sigmoid sinus, occipital sinus, etc.) (b) Also avoid the neighborhood of the larger blood vessels, particularly the middle meningeal artery. (c) In general, avoid puncturing through a small opening because of the difficulty of seeing what one is puncturing and of recognizing hemorrhage promptly, when it occurs. (d) Do not puncture through a sulcus, but through the convexity of a convolution, because in the sulci run the vessels.

2. Explore for pus through the lowest possible openings, thus securing the best possible drainage, if pus be reached.

3. Tap hematomata from the point of visible injury (unless there are other focal symptoms and the visible injury is slight).

Technic of Simple Puncture. The locality of the puncture is shaved, washed with soap and gauze, alcohol and bichloride, 1:1,000. Local anesthesia is usually sufficient, but an anesthetist should be at hand and all preparations, as a rule, should be made for a flap operation, if it becomes necessary. (a) Freezing with ethyl chloride, or (b) infiltration with Schleich's solution (No. 1), or novocain (½ per cent. with 12 m. of adrenalin, 1 per cent. to the 100 cc.) may be employed.

A small, semicircular scalp flap may be made or the drill may be pushed directly through the scalp and set at once to work on the bone. If Hudson's[63] trephine is to be used, it is best to make a small flap.

The drilling through the bone should then be done in the direction in which the needle is later to be inserted, rather than at right angles

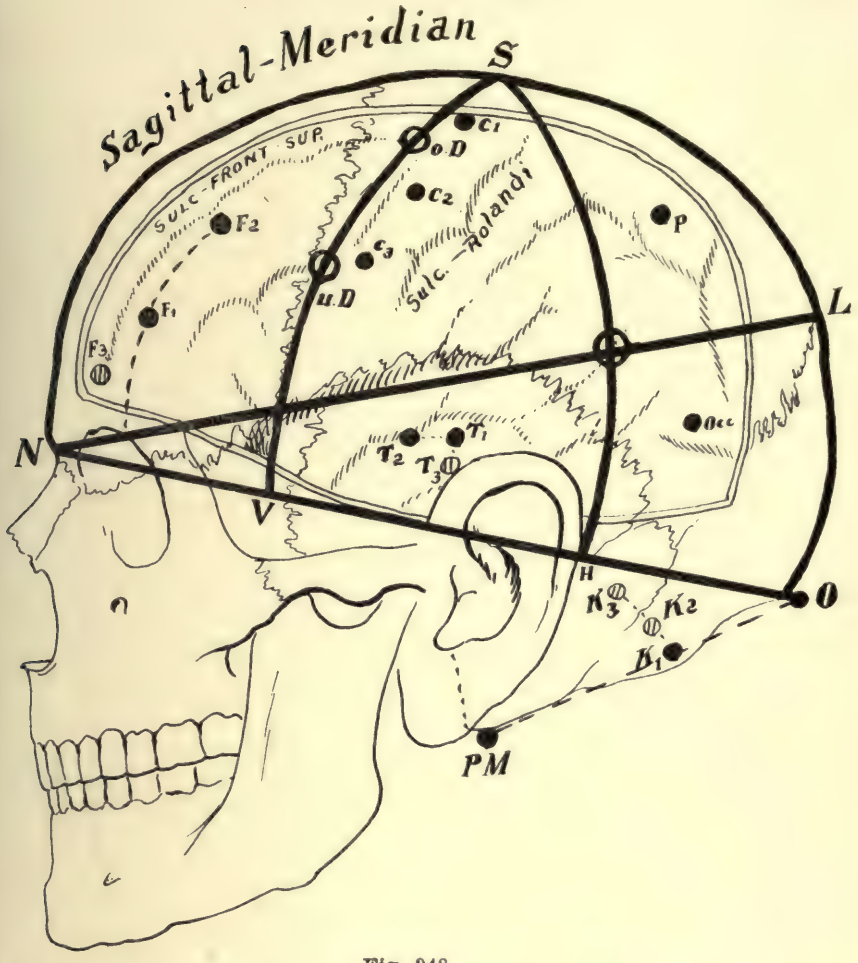


Fig. 948.

Cranial Puncture Points. (Neisser and Pollock). Heavy Black Lines are the Craniometer Lines. Solid Black Points indicate Puncture Areas of the Different Lobes. Shaded Points for Puncturing Abscesses.

F^1 F^2 F^3—Puncture point for frontal lobe.
T^1 T^2 T^3—Puncture point for temporal lobe.
Occ.—Puncture point for occipital lobe.
P—Puncture point for parietal lobe.
K K K—Puncture point for Cerebellum lobe.
P M—Mastoid process.
O—Ext. occip. protuberance.
N—Nasion (gabella).
S V—Line of direction of precentral sulcus (anterior diagonal meridian).
S H—Posterior diagonal meridian.
N O—Base Line.
N L—Naso-lambdoid line.
O D—Juncture of upper and middle third of the central gyrus.
N D—Juncture of lower and middle third of central gyrus.

to the bone. A metal shoe may be attached about the shaft of the drill (1 to 1½ cm.), so that it will not suddenly penetrate the bone and lacerate the brain beneath. The position of the shoe may be gradually changed as the drill goes farther in. When the bone has been penetrated the needle should be inserted, after the drill is removed, and the scalp should be held fast, free of the bone, at each side of the opening by an assistant.

It may happen, especially in trephining through thick, fleshy parts, especially in fat parts, as in the occipital or temporal regions, that it becomes impossible to locate the small trephine opening with the needle point, thus necessitating trephining anew. The needle should be about six inches long, graded in centimeters, no thicker than 1.8 mm., and provided with a mandrin. The needle should be attachable to an aspirating syringe of about 5 cc. (1-10 cc.) capacity, and provided with a glass cylinder, so that fluid can be seen, if aspirated. The tip of the needle is then inserted through the dura and gently advanced in the desired direction up to a depth of five or six centimeters, depending on location.

If no fluid appears the aspirating syringe may be attached and gentle suction exerted as the syringe is withdrawn.

If fluid is not found, the needle is cleaned out with the mandrin and then inserted in a new direction. It should never be moved into a different area of the brain without first withdrawing it entirely and also examining its patency.

When the examination has been completed the wound is washed off with bichloride, 1:1,000, and alcohol, and then sealed with collodion and cotton. A stitch or two may be necessary, depending on the size of the opening in the scalp.

SPINAL PUNCTURE.

Although the chemical and physical characters of the spinal fluid in health and disease, its origin and movements, have been studied in animals and man since Cotugno's time (1769), it is only of recent years [Quincke, 1891] that we have been able to use it for diagnosis and therapy.

Indications. The chief indication for the performance of lumbar puncture occurring in connection with eye symptoms is *meningitis* in its various forms. Here the puncture is an invaluable diagnostic aid and likewise an important aid to therapy. All other indications are very infrequent when compared with meningitis, the presence of which can be diagnosed and its varieties differentiated by examination of the spinal fluid obtained.

---

[a]Hudson. *Surg., Gyn. and Obst.*, Feb., 1910, Vol. X, p. 180.

Drainage of pus and *irrigation* to a slight extent may be practised by means of the puncture, but much more important, from a therapeutic standpoint, is the injection of the Flexner serum into the subarachnoid space in cases of epidemic meningitis.

Intrameningeal hemorrhage may also be diagnosed by the puncture, but always has an element of doubt, inasmuch as a vessel wounded by the needle may lead to a similar finding, although in the latter instance the blood, as a rule, is redder than in the former, and less

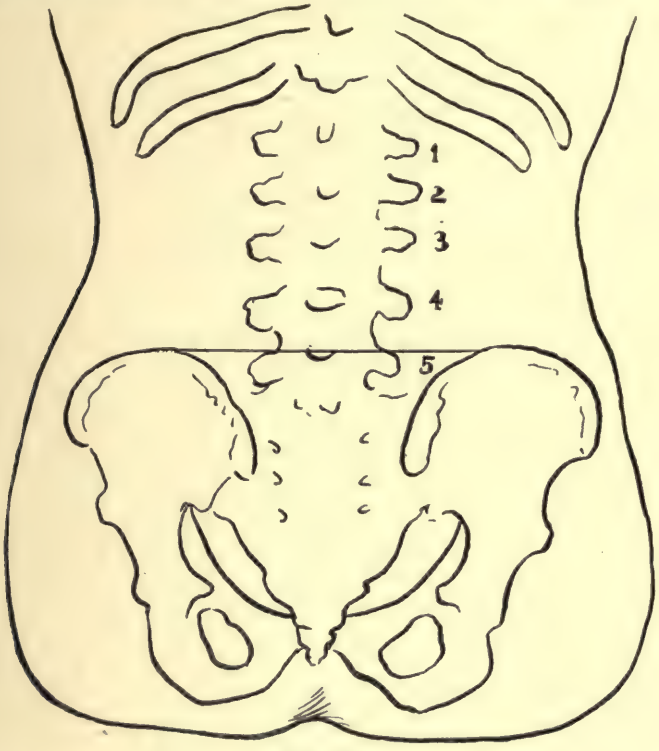


Fig. 949.

Spinal Puncture. Relations between the Lumbar Spines and Crests of the Ilia shown by the Transverse Line.

diffusely distributed through the fluid, being usually more marked in the first few drops than in the last.

Increased intracranial pressure, whether due to tumor cerebri, hydrocephalus, hemorrhage or meningitis, may often be diagnosed by the increased pressure of the spinal fluid, which, normally flowing 60 m. per minute from the needle, may fairly spurt out when pressure is high. The normal pressure is 5 to 7½ mm. of mercury, or 60 to 100 mm. water, which may be increased under pathological conditions to 15 to 60 mm. of mercury, or 200 to 800 mm. of water.

In the last few years the cytological, chemical and biochemical examinations of the spinal fluid, as obtained by spinal puncture, have assumed great importance in the diagnosis of syphilis and the parasyphilides.[64]

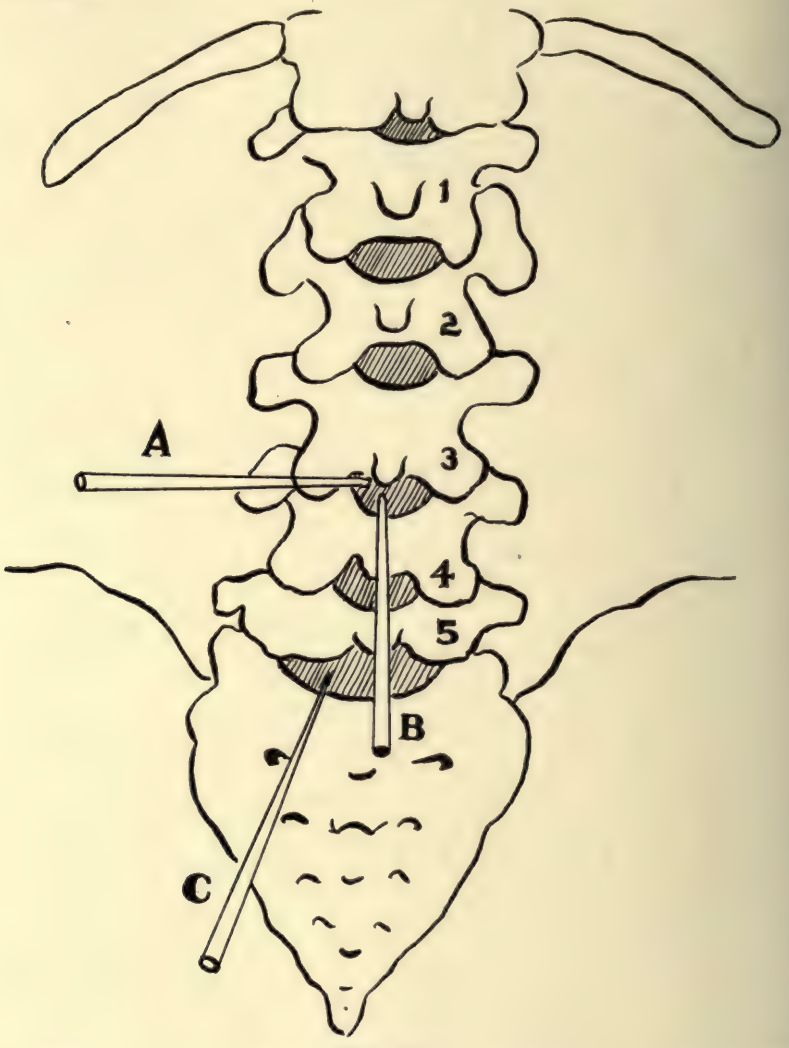


Fig. 950.

Method of Puncture for Spinal Drainage. A, Quincke's site; B, Marfan's site; C, Chipault's site.

The mononuclear leucocytosis, excessive presence of globulin, the Wassermann and Noguchi tests have made the differentiation of the

[64]Cornell. The Cerebrospinal Fluid in Paresis. *Amer. Jour. of Insanity.* Vol. LXIV, No. 1, July, 1907, p. 73.

parasyphilides from syphilis, and both from non-syphilitic affections, much more accurate.

Other less important indications are derived from the presence in the spinal fluid of an excess of urea in uremia, and the presence of

Fig. 951.

Topographical Relations for Spinal Puncture, according to Tuffier. The line joining the crests of the ilia passes directly over the spinous process of the fourth lumbar vertebra. The needle is inserted just above the spinous process to reach the third interspace, or below it to reach the fourth.

cholesterin and cholin in cases of various degenerative processes of the central nervous system.

Therapeutic Indications Of Spinal Puncture.

The application of therapy by means of spinal puncture is always associated with danger to life. The evacuation of fluid, whether it be normal, purulent or hemorrhagic, always entails some risk of allowing the medulla to sink into the foramen magnum and become incarcerated there, to the detriment of its vascular supply. The central canal and subarachnoid space may also become blocked, thus leading to an acute hydrocephalus or pyocephalus, as the case may be.

To avoid this danger only a small amount of fluid, usually 20 to 40 c.c., should be evacuated at one time, and the patient should be placed in the lateral, and *not* in the sitting position during the procedure.

The evacuation of the pus in meningitis by spinal puncture is not of much therapeutic value. Puncture is of importance here chiefly because it enables us to introduce Flexner's antimeningococcic serum directly into the subarachnoid space. For this serum injection the needle is introduced in the ordinary way, a few drops of fluid allowed to escape, and then the serum is injected through the needle—20 to 100 c.c. The procedure may be repeated every day until convalescence begins. The unanimous enthusiasm of clinicians over the whole world proves the great value of this procedure. By it the mortality of the scourge has been reduced from 75 to 25 per cent. wherever it has been used. It is a great discovery of which America may well be as proud as France is of Behring's serum.

The treatment of increased intracranial tension by lumbar puncture had considerable vogue to within the last few years, Cushing[65] has laid such emphasis, however, on the danger of medullary hernia into the foramen magnum in such cases, and there have been so many such cases reported, that it would seem hardly justifiable at the present writing to adopt such a procedure, in view of the excellent results now obtained by cranial procedures.

Technic Of Spinal Puncture.

Quincke recommended that the puncture be made between the second and third, or third and fourth, vertebræ. I nearly always use the latter location because of the readiness with which it is found by drawing a line between the crests of the ilia. This line passes over the fourth lumbar spinous process and just above it I insert the needle.

---

[65]**Cushing.** Some Principles of Brain Surgery. *Jour. A. M. A.*, Jan. 16, 1909, p. 184.

Many clinicians recommend that the puncture be made in the mid-line. I prefer, however, to enter the needle one-half to one centimeter to one side of the median line, as originally proposd by

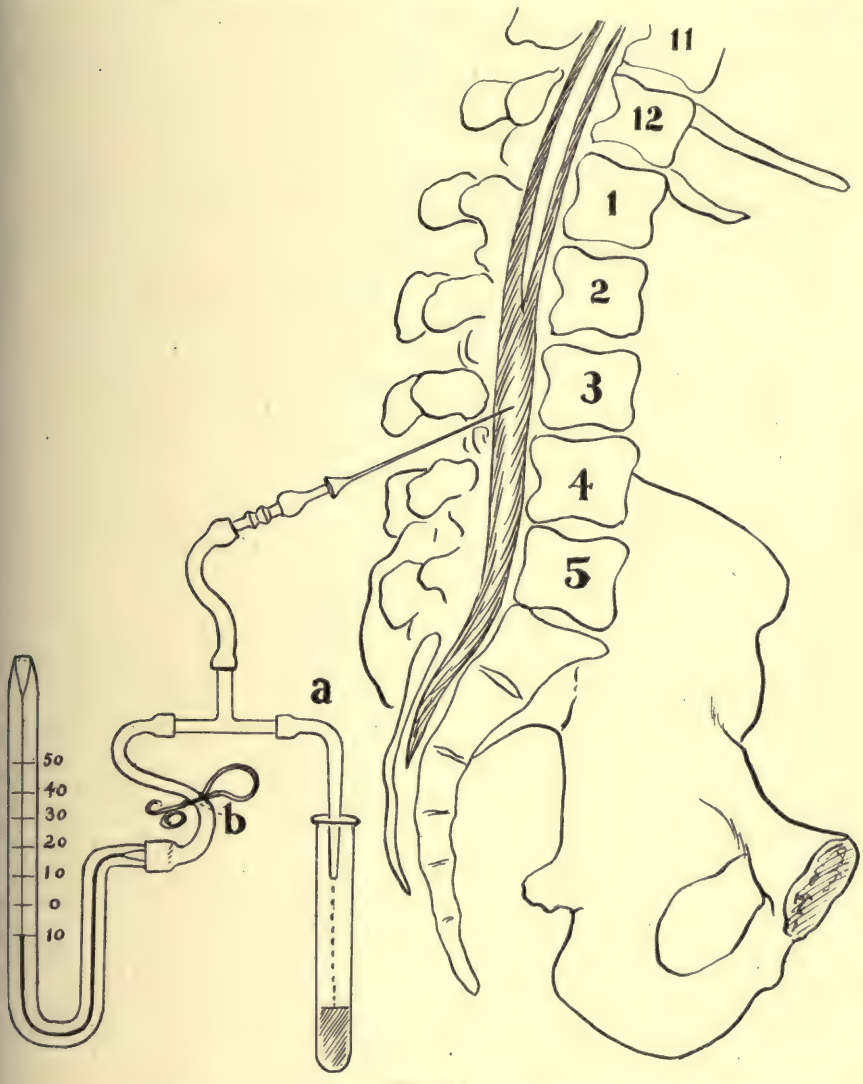


Fig. 952.

Diagram of Lumbar Puncture. T-shaped glass tube for combined drainage and estimation of the pressure of the spinal fluid.

Quincke, in order to avoid going through the tough ligamentum interspinosum.

The needle can also be inserted between the fourth and fifth

vertebræ or between the fifth vertebra and the sacrum, and it is not improbable that in an occasional instance pathological constituents of the spinal fluid, which have settled to the lowermost part of the subarachnoid space, may be found here, though missed on puncture at the usual location. Such an occurrence, however, is certainly very rare and is not a practical consideration.

The needle, once entered in the skin just outside the mid-line, is pushed inwards, slightly upwards—in adults, horizontally in children, and medianwards. The dura is reached at a depth of four to six centimeters in adults, or of two centimeters in a two-year-old child. If the tip of the needle engages bone at the first attempt, withdraw a little, change the direction and try again.

The position of the patient during the puncture should be the lateral recumbent, with the spinal column flexed to a maximum, in order to enlarge the posterior intervertebral aperture.

I prefer the recumbent to the sitting posture because I believe that there is less danger of cerebral vascular disturbances or hernia of the medulla into the foramen magnum in the lying position.

When the spinal fluid runs out it is caught in a sterile test tube. The rate of flow and incidentally the pressure of the spinal fluid is determined by counting the drops as they flow from the end of the needle. The normal rate of flow is about sixty drops per minute. More than this number means increased spinal and consequently increased intracranial tension. Occasionally, when the pressure is very high, the fluid may flow in a continuous stream instead of in drops. A number of drops less than sixty per minute indicates either hypotension or partial plugging of the needle.

The needle should be withdrawn as soon as the pressure falls to normal. As a rule, it is safe to stop somewhat before normal in view of the ever-present danger of hernia of the medulla into the foramen magnum.

It seems hardly necessary to state that the needles should be sterilized by boiling in one per cent sodium carbonate solution, and the skin sterilized by some one of the accepted methods. Simple disinfection with 95 per cent. alcohol or painting on of tincture of iodine, according to Grossich,[63] is enough.

An anesthetic of any sort is usually not necessary, though it may be desirable at times to anesthetize the skin with the ethyl chloride spray.

The examination of the spinal fluid is more appropriately to be discussed in one of the standard textbooks on laboratory diagnosis.

---

[63]Grossich. Eine Neue Sterilisierungsmethode der Haut bei Operationen. *Zentralbl. f. Chir.*, Oct. 31, 1908, Vol. XXXV, No. 44, p. 1289.

such as Webster's *Diagnostic Methods,* Blakiston, 1909; Wood's *Clinical Chemistry,* Appleton, 1905; Sahli's *Klinische Unterrsuchungs-Methoden,* F. Deuticke, Wien, 1909.

One of the more recent textbooks is advisable, since otherwise the important new biochemical reactions of the spinal fluid, like the Wassermann, Noguchi, and Nonne-Apelt will be missing.

SURGICAL TREATMENT OF EXOPHTHALMIC GOITRE.

The history of exophthalmic goitre dates from the report of a case by Parry,[67] in 1786. No complete study of it is found in the literature until Basedow,[68] in 1840, presented a thesis upon the subject, in which he described its most characteristic symptoms. From this time the disease has been known in Germany by the name of Basedow's disease. Previous to Basedow's description of the cardinal symptoms, namely, exophthalmos, goitre and tachycardia, Graves,[69] in 1835, in England, described what he termed "cardio-thymoid exophthalmos," but did not depict a typical case of primary exophthalmic goitre. In England, up to the present time, the disease has been known as Graves' disease. Basedow's observations had led him to regard the disease as due to chlorosis. Later studies made by von Graefe,[70] Köber[71] and Charcot[72] directed attention to the derangement of the sympathetic as the probable cause of the symptoms.

In the recognition of what we now consider the symptom-complex of this disease credit belongs to a number of clinicians. Charcot first observed the fine tremor so often seen; Tissier[73] the elevation of temperature; Chvosteks[74] the diminution of electrical resistance of the skin; von Graefe the failure of the upper lid to follow the eyeball in lowering of the plane of vision. Lastly, it was mentioned that Möbius,[75] in 1883, first directed attention to the lessened power of convergence in persons suffering from this disease. He was also the first to advance the theory that the disease is due to an increased pathological activity of the thyroid gland.

In the study of the pathological anatomy, early observers, among

---

[67]Parry. Legg. History of Exophthalmic Goitre, *St. Bartholomew's Hosp. Reports,* Vol. XVIII, 1882, p. 7.

[68]Basedow. Ibid.

[69]Graves. Ibid.

[70]von Graefe. *Berl. Med. Gesellsc.,* March 9, 1864. Abstracted in *Berliner Klin. Wochenschr.,* April 11, 1864, Vol. I, p. 167.

[71]Köber. Cited by von Eiselsberg.

[72]Charcot. *Gaz. de Med. de Paris,* 1856.

[73]Tissier. Goitre Exophtalmique et Hydrothérapie. *Paris Médicale,* 1898. Jan. 21, p. 33.

[74]Chvostek. *Wiener Med. Presse,* 1871.

[75]Möbius. Nothnagel's *Special Pathology and Therapy,* 1896, XXII, pt. 2, p. 1. Die Basedow'sche Krankheit, 1896.

whom we may mention Müller,[76] White Copper[77] and Martius,[78] confined their studies chiefly to the condition of the nervous system and particularly to the medulla and the cervical sympathetic. In the medulla no changes of importance were found, although petechial hemorrhages were observed in the cord. These hemorrhages were recent and evidently occurred at the time of death, and therefore could bear no causal relation to the symptoms that were of long duration. The only observer who found positive evidence of disease in the medulla was Mendel.[79] He found, in one case, the left restiform body atrophic, with degenerative changes in the solitary bundles of the opposite side. As no one else has since found anything abnormal in the restiform bodies in exophthalmic goitre, and as a similar atrophy has been found by Oppenheimer[80] where no symptoms of exophthalmic goitre existed during life, it is probable that there exists no relation between the findings of Mendel and the disease under consideration.

The greatest effort has been made to establish a relation between the exophthalmic goitre and lesions of the sympathetic. Virchow, Trousseau, and von Recklinghausen and others have found atrophy of the nerve elements with increase in connective tissue of the cervical sympathetic, particularly in those fibers that supply the heart. This sympathetic atrophy is frequently found post-mortem. Furthermore, the histologic structure of the sympathetic ganglia varies much, even in the same subject, one ganglion showing all the signs of atrophy with pigmentation which is considered pathologic, while others may be normal. These changes in the ganglion may be found in subjects that never presented any symptoms during life that would indicate disease of the ganglion. Similar degenerative changes in the pneumogastric nerves have been considered the cause of exophthalmic goitre. As in the sympathetic, it has been found that degenerative changes are common in the pneumogastric and bear no relation to this disease.

As first shown by Möbius, the essential cause of the disease known as exophthalmic goitre is a hypersecretion of the thyroid gland. The many symptoms presented are undoubtedly due to a toxemia. This condition is now generally termed hyperthyroidism. It is not unlikely, therefore, that definite and constant pathological

[76] Müller. *Deutsche Arch. f. Klin. Med.*, 1893, Bd. 51, p. 335.
[77] W. White Cooper. *Lancet*, May 26, 1849, p. 551.
[78] F. Martius. *Thèse de Paris*, 1890; *Berliner Klinik*, 1896. Pt. 95, pp. 1-19.
[79] Mendel. *Schmidt's Jahrb.*, 234, s. 134; also, *Deutsche Med. Woch.*, Zur Pathol. Anat. des Morbus Basedowii. Bd. VIII, 5, 1892, p. 89.
[80] Oppenheimer. Myoedema and Exophthalmic Goitre in Sisters. *Journal of Nervous and Mental Diseases*, April, 1895, Vol. XX, No. 4, p. 213.

changes are to be found in the thyroid gland. In nearly all the type of goitre corresponds to an hypertrophy of gland tissue, either circumscribed or diffuse. The gland may not be greatly enlarged. Microscopically, the alveoli are not found increased in size, but there is present a hyperplasia of the epithelial lining, either as one layer or in reduplication of layers of epithelial cells. There may also be found an infolding of the alveolar wall with the formation of papillæ in the alveoli. In some cases in place of a hypertrophy an actual hyperplasia of gland tissue, with a numerical increase of the follicles, exists. This increase in the number of follicles is associated with hyperplasia of the lining epithelium of the alveoli. Degenerative changes with desquamation of alveolar epithelium are to be seen in more chronic cases. Degeneration of active functionating cells may with blocking of the lymphatics bring about a cessation of the symptoms due to hypersecretion of the gland. In this way a spontaneous cure takes place, providing the patient lives long enough.

Most observers are agreed upon the following gross characteristics of the thyroid gland in true exophthalmic goitre:

1. Generally diffuse enlargement of the gland, with a firm elastic consistency, the firm consistency being due to the lumen of the follicles being relatively free from colloid and filled with epithelial cells.

2. Expansile pulsation due to increased vascularity often approaching the type recognized as the struma vasculosa. This is due to an increase in the size and number of the vessels, both arteries and veins, of the gland. Albert Kocher[81] is authority for the statement that in their clinic all cases of exophthalmic goitre examined presented indubitable evidence of an increased vascularity both of the capsule and substance of the gland.

Although the pathogenic changes just described, and which correspond closely in most respects with those found in simple diffuse hypertrophic goitre, are considered by von Eiselsberg[82] and others as constant and pathognomonic of exophthalmic goitre, yet any anatomical form of goitre may be associated with symptoms of hyperthyroidism, viz., tachycardia, tremor, etc. The cases are best termed secondary exophthalmic goitre or simply as hyperthyroidism.

In other organs, changes of a secondary character are found. Frequently the heart is dilated; there may be hypertrophy of the left ventricle; in many, fatty degeneration of the muscle and myocarditis

---

[81]Albert Kocher. *Mitt. a. d. Grenzgb. d. Med. u. Chir.*, Bd. II, Heft. I, pp. 1-304.

[82]von Eiselsberg. Die Krankheiten der Schilddrüse, *Deutsche Chirurgie*, 1891, Lieferung 38.

are present. A constant finding is the widespread changes in the voluntary muscles throughout the body. In old cases, intramuscular lipomatosis and degeneration of the muscle cells is a nearly constant finding.

The degeneration which takes place in the muscles throughout the body, and which is probably the direct result of the action of a toxic substance upon them, explains practically all the symptoms of the disease. To these changes we can trace the origin of the tremor, the general emaciation, and the loss of converging power. A weakening of the pharyngeal and tongue muscles from the same cause will give the so-called bulbar symptoms which were formerly regarded as evidence of disease of the medulla. The phenomenon of Bryson—loss of inspiratory expansion of the muscles of the thorax—depends upon a degeneration of the muscles of inspiration; namely, the thoracic muscles and the diaphragm. Lastly, the exophthalmos may be explained by the weakening of the ocular muscles, that permits of over-distension of the vessels of the eye and causes the bulging forward of the organ. This over-distension is the direct result of the loss of support furnished by the muscles that normally control the eye and retain it in place. Frequently enlargement of the lymphatic glands is found throughout the body. This is often associated with a persistent thymus gland giving the anatomical findings that have been termed the status thymicus, or status lymphaticus. In the absence of any other known cause, it would seem reasonable to suggest a possible relation between a diseased condition of the thyroid gland and this lymphatic hypertrophy.

The *surgical history of exophthalmic goitre* dates from the publication of Tillaux,[83] in 1880. In 1884 Rhen[84] reported four cases of exophthalmic goitre cured by partial thyroidectomy. Both operators resorted to surgical measures because of the local condition, size and character of the goitre, which called for removal of the tumor, and not with the idea of curing the disease. In both the cessation of the active symptoms of the disease was unlooked for.

Others during this decade (1880-1890) operated with success, although the exact way by which a cure was brought about was not understood. Of those who were among the first to develop and improve operative technic may be mentioned Krönlein, Kocher, Riedel, Mikulicz and Lemke. Heydenreich, in 1895, published 61 cases, of which 51 recovered or were greatly improved, 4 died, and 6 were not benefited.

---

[83]Tillaux. Thyroidectomie pour un Goitre Exophtalmique. *Bull. de l'Acad. de Med. de Paris*, April 27, 1880.

[84]Rhen. "Ueber die Extirpation des Kropfes bei Morbus Basedowii." *Berliner Klin. Woch.*, XXI, No. 11, 1884, pp. 163-166.

After the publication of the excellent monograph of Möbius, in 1895, in which a definite pathology was established, the operative treatment was generally accepted as providing the most certain method of diminishing the pathologic secretion of the gland by removal of a part of the diseased organ.

Indications For Operative Treatment of Exophthalmic Goitre.

In my opinion, the favorable results obtained by the operative removal of a portion of the thyroid gland, whenever symptoms of hyperthyroidism exist, should lead us to adopt this method of treatment in all cases where the symptoms are not readily controlled by the usual non-surgical remedial agents.

Of the special indications which may be considered as positive for operative treatment of this disease, I may mention: 1. When the degree of exophthalmos is such that destruction of the eye from ulceration and infection is imminent. In long-standing cases the usual operative procedure, partial thyroidectomy, may not immediately bring about the desired result. It is in this class of cases that the operation of total excision of the cervical sympathetic has been extolled, particularly by Jonnesco and Jaboulay. After partial thyroidectomy in the more acute cases, the recession of the eye may be immediate. I have seen a marked decrease in the degree of exophthalmos occur during the first few hours after the operation. Accepting the reports of the cases treated by total cervical sympathectomy, it would appear that improvement in the exophthalmos occurs with more certainty and even earlier than after operative procedures on the thyroid gland.

2. A second positive indication for operative treatment is where the goitre is large and the pressure symptoms are urgent. In these cases no delay should be tolerated if the general condition of the patient warrants an operation. If the patient's condition does not warrant removal of a portion of the gland, relief from the most urgent manifestations of pressure may be had in selected cases by division of the isthmus of the gland, evacuation of cysts or by tracheotomy, if the anatomical relations of the organs permit.

A small-sized goitre need not influence against an operation. Frequently, with comparatively small glands, the effects of excessive secretion with resulting toxemia are most pronounced.

A contraindication to operative treatment is excessively high pulse rate, particularly if it is irregular or weak and thready in character. Generally an operation under a general anesthetic is contraindicated if the pulse rate reaches 180. When in selected cases the less dangerous operation of ligation of the superior thyroid vessels

is selected, this high pulse rate may constitute only a relative contraindication.

Edema, if general, exhausting diarrhea and ascites and prolonged vomiting constitute positive contraindications to any operative treat-

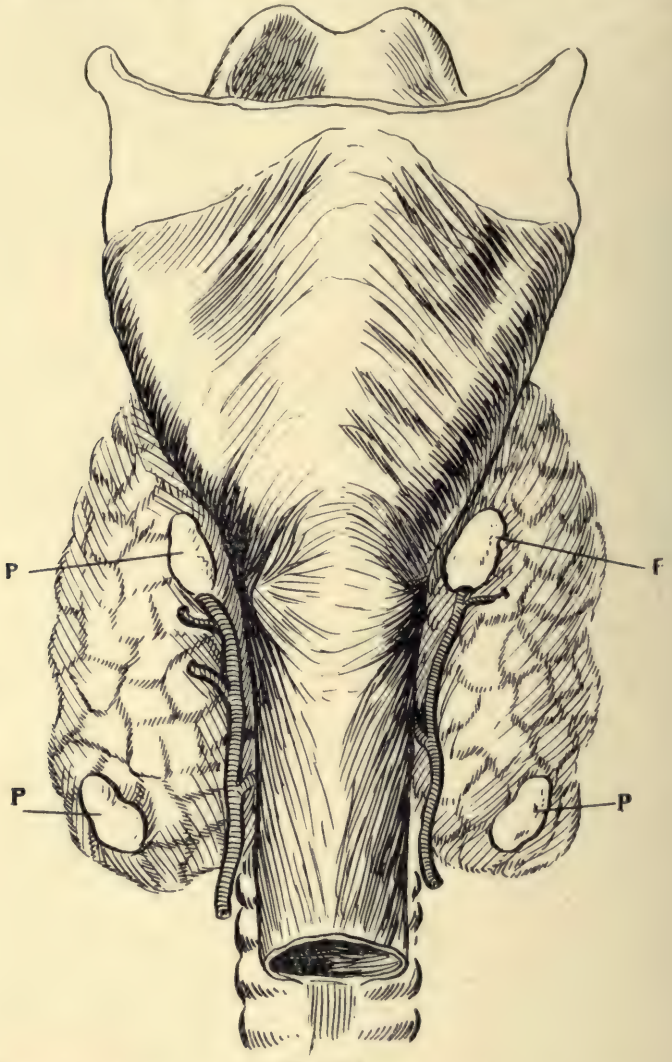


Fig. 953.

Parathyroid Glands in their Normal Relations to the Thyroid Gland. (After Ochsner).

ment until by rest and judicious medical treatment the patient's general condition is improved to a point when operative measures may be considered. In general, a dilatation of the heart, sufficient to be

recognized by physical signs, constitutes a contraindication to operative treatment, excepting when the operation is done under local anesthesia.

It may be stated, in general terms, that in the most severe forms of exophthalmic goitre, when the pulse rate is extremely high, with wide variations in volume and rhythm, and where there are other evidences of a high grade of toxic myocarditis, or where psychic disturbances are manifested, no operation should be considered.

As a preparation for operation in severe cases, these patients should be placed at rest in bed and receive such medical treatment as their peculiar symptoms demand.

Frequently, as a result of rest and quiet alone, great improvement may be noted. If this desired result is attained, an operation when the patient's condition is most favorable may be considered. If, on the other hand, the symptoms do not improve, or become worse, an operation should never be considered as a last resort. In this class of cases a fatal outcome is to be expected and to operate under these conditions results only in discredit to the art of surgery.

The *operative procedures employed in the treatment of exophthalmic goitre* may be classified as follows:

1. Operations on the gland itself. (a) Partial excision, generally unilateral thyroidectomy. (b) Enucleation of cysts, cystic tumors and encapsulated growths, as adenoma. (c) Incision and drainage of cysts. (d) Exothyropexy.

2. Ligation of thyroid vessels.

3. Operations on the cervical sympathetic nerves and ganglion. (a) Section of sympathetic cord, either unilateral, as practised by Edmonds, or bilateral, after Jaboulay. (b) Partial resection, Jaboulay, Vignard and Quenu. (c) Total bilateral resection by which the three ganglia on each side, with their connecting cords, are completely removed, Jaboulay.

At the present time the operation usually chosen in the treatment of exophthalmic goitre is unilateral or partial excision of the gland. The technic is practically the same as when a portion of the gland is removed in simple goitre.

The Author's Technic for Operating on the Thyroid in Graves' Disease.

1. Position of the patient: The patient should be placed upon the operating table with the head slightly elevated and the tumor brought into prominence by placing a (bolster) pillow between the shoulders and underneath the neck.

2. Anesthetic: Formerly it was our practice to operate under Schleich's method of local anesthesia, employing a 1:1000 solution of

cocaine for infiltration of the skin and subcutaneous tissue. During the last two years this method has been abandoned and ether anesthesia by the drop method from an open mask has been used exclusively. Our reason for substituting ether anesthesia for local is that we believe that the psychic shock where the patient is not rendered unconscious is generally more dangerous than is the effect of a gen-

Fig. 954.
Kocher's Transverse or Collar Incision in Strumectomy.

eral anesthetic. It is also true that the operator is not capable of doing his work as expeditiously and as dextrously when operating with the patient conscious.

We believe that chloroform is in every case contraindicated by reason of the toxic myocarditis that is an essential and constant feature of the disease.

Here, as in brain surgery, the success or failure of the operation in a considerable measure depends upon the skill of the anesthetist. In all cases he prepares himself as if he were to assist in the operative work by scrubbing the hands and donning gloves, gown, cap and mouth gauze.

3. Preparation of the field of operation: This is generally made after the patient has been anesthetized. Preliminary preparation, as carried out in other operations, is not practised in exophthalmic goitre, for the reason that any psychic stimulation greatly increases the activity of the gland, thereby increasing the toxemia, thus enhancing the dangers of the operation.

We believe with Crile that before the operation anything that would tend to excite the patient should scrupulously be avoided. For this reason no preparation of the field is made until after the anesthesia is complete.

Kocher warns against the use of strong antiseptic solutions even on the skin of a patient suffering from exophthalmic goitre. He claims that the greatly increased capability of absorption in these cases renders their use extremely dangerous. It is our plan to scrub the skin lightly with gauze, using green soap and then alcohol only. No other antiseptic is employed.

4. Skin incision. We employ the Kocher transverse incision through the skin and platysma over the more prominent part of the tumor. The incision, starting from the outer border of the sterno-mastoid, passes across the neck with the convexity downwards. A generous incision is to be recommended. The skin and platysma are now reflected upwards, exposing to view sterno-hyoid, sterno-thyroid, omo-hyoid and sterno-mastoid. The vessels in the skin, of which the most important are the anterior and external jugular veins, are caught and immediately ligated with fine iodized catgut.

The medium line of the neck is sought for and the fascia divided upwards to the lower border of the larynx. The depressor muscles of the larynx of the two sides may then be separated. In small-sized tumors, lateral retraction of these muscles may be sufficient to permit of dislocation of the part of the gland to be removed. Generally transverse division of the sterno-thyroid and sterno-hyoid at a level slightly above the skin incision will be found necessary. This should be done only after the muscles are first secured above and below by forceps that prevent retraction of the divided ends. In extremely large glands the inner border of the sterno-mastoid may be incised.

The lamina of the deep cervical fascia forming the fibrous capsule of the gland is recognized and divided transversely across the portion of the gland to be removed.

The second step consists in freeing the gland from the fibrous capsule by blunt dissection or with the fingers, and dislocating the lateral half of the gland outwards to the surface of the neck. Hemorrhage from small vessels torn by this act is controlled immediately by ligature.

The operation is continued by retraction of the sterno-mastoid outwards and the fibrous capsule and superficial soft structures upwards, exposing the superior pole of the gland with the superior thyroid vessels. These are isolated and crushed by a heavy artery forceps and ligated first separately and then together, and severed between the ligatures and a large Kocher forceps placed close to the gland.

The partially liberated gland is now drawn toward the opposite side, the sterno-mastoid retracted farther outwards and the inferior thyroid artery sought for at the lower and outer angle, where it reaches the gland by passing underneath the carotid after being given off from the thyroid axis. The recurrent laryngeal nerve is generally behind the artery. By making gentle but firm traction toward the opposite side and upwards, the artery is rendered tense and may be felt as a pulsating cord. If at the same time the gland is lifted forward the artery may be separated from the recurrent laryngeal nerve behind. This act is of great importance in preventing injury to the nerve when the ligature is applied to the vessel.

Ligation of the main trunk of the vessel should be made as close to the surface of the gland as practicable, so as to still further insure the safety of the nerve.

In ligating both the superior and inferior thyroid vessels, I always employ Pagenstecher linen for the ligature material. This offers additional security against the ligature slipping, with the consequent serious hemorrhage.

The middle thyroid vein should be isolated and tied with a separate ligature of linen. The thyroid ima artery, with its accompanying vein, should be searched for on the median side of the dislocated lobe. If present, they should be tied.

The lateral half of the gland is now separated carefully from the fibrous capsule posteriorly as far as the isthmus. This is well freed from the trachea and caught with a Kocher goitre clamp and crushed. It is now divided distal to the clamp with a cautery knife. Ligation is unnecessary. The wound is now sponged dry and all bleeding points secured by forceps and then ligated. The most absolute hemostasis must be secured.

The wound is carefully washed with normal salt solution, the divided muscles reunited by catgut sutures and tubular drainage in-

serted into the deepest angle of the wound. The skin is sutured, excepting at the exit of the drains, by a continuous horsehair suture. The wound, excepting the point where drainage passes out, is covered with silver foil and a large dressing applied.

At the end of forty-eight hours the tubular drainage is removed

Fig. 955.

Kocher's Angular Incision in Unilateral Resection of the Thyroid Gland; Skin, Fascia and Platysma Divided; Median Jugular Vein Crossing the Incision.

and, if the discharge of wound secretion is small, no other drain is inserted. If, on the other hand, the secretion from the gland and the wound is still considerable, a small strip of gutta percha tissue is inserted and secured by a safety pin. At the end of the fourth day

all drainage is removed and the wound sealed with collodion over the silver foil.

Opium and belladonna are given after the operation in sufficient quantities to secure rest and quiet for the patient.

Dangers and Complications of Thyroidectomy.

In common with operations on simple goitre, hemorrhage, either immediate or subsequent, constitutes an element of danger. Hemorrhage at the time of the operation is more to be feared in exophthalmic goitre than in excision of the gland in ordinary cases of goitre. In the former the great vascularity of the gland, the increased friability and lost retractile power of the walls of the vessels, as shown by Albert Kocher[85] and Gerhardt,[86] constitute an important factor in the causation of a dangerous hemorrhage. In the late stages of the disease in particular we find extensive degeneration of the media, with loss of elastic substance and separation of the media and adventitia, rendering the structure of the vessel exceedingly brittle. As a consequence, small vessels are not automatically closed and the large ones frequently are torn through by the ligature permitting a continuation of the hemorrhage or later promoting a secondary hemorrhage. A second frequent cause of secondary hemorrhage is the inclusion in the ligature of a portion of muscle, which, upon contraction of the muscle, pulls the ligature from the vessel. This accident can be avoided if the vessels are isolated carefully before ligature is applied and the dangers of muscle inclusion are borne in mind. In simple goitre, when the vascular system is in a relatively normal condition, a considerable loss of blood can be borne without great risk to life. In exophthalmic goitre, especially in the later stages of the disease, with toxic myocarditis and cardiac dilatation, a relatively small hemorrhage may prove fatal.

Besides the dangers incident to operation for simple goitres, we have in exophthalmic goitre certain conditions that may be developed during and after the operation that may cause a fatal termination. It is well-known that patients suffering from this disease, especially those with pronounced tachycardia, bear general anesthesia of any kind badly. The degenerated heart muscle, with the increased irritability of the heart centers in these cases, greatly increases the chance of death in chloroform narcosis. In other cases where the goitre is large, or in the retro-sternal or retro-clavicular struma, the dangers from ether are equally great. In a few no general anesthetic should

---

[85] Kocher. *Mitt a. d. Gr. der Med. und Chir.*, Bd. 9, 1902, pp. 1-304.

[86] Gerhardt. Ueber das Verhalten der Körperarterien bei Basedow'scher Krankheit. *Mitt. a. d. Grenzgebiet der Med. und Chir.*, 1896, Vol. 1, pp. 135-138.

be given. In quite a number of cases the symptoms that were present before operation become greatly exaggerated immediately following it. The pulse increases in frequency and becomes arhythmical, the exophthalmos becomes more pronounced, tremor and elevation of temperature rapidly increase. Great muscular weakness and delirium,

Fig. 956.

Unilateral Thyroidectomy Through Kocher's Angular Incision after the Fibrous Capsule has been Incised and the Lateral half of the Gland Dislocated toward the Median Line; the Sterno-Thyroid and the Sterno-Hyoid Muscles cut. The Inferior Thyroid Artery and Recurrent Laryngeal Nerve are shown at the Lower Angle of the Wound.

with suppression of urine, are the symptoms which usually precede speedy dissolution. These symptoms are due to an escape into the tissues, thence into the circulation, of a large quantity of toxic secretion of the gland. The already weakened nerve centers are simply overwhelmed and the patient succumbs.

It is rarely after an operation for exophthalmic goitre that we see a case run an apyretic course. Usually, for a while at least, the pulse is accelerated and the temperature elevated, even where no sepsis is present. Sudden deaths some hours or days after the operation may unexpectedly occur. These deaths are probably the result of general lymphatic and thymic hypertrophy, which is so often found in cases of exophthalmic goitre. It is now well-known that sudden death, when no operation has been performed, is a possible termination of these cases of status lymphaticus. On post-mortem nothing but degeneration of the heart muscle and general lymphatic hyperplasia is found.

Death from collapse of the trachea occurs after operation for any form of goitre. Fütterer has shown that in cases where continued pressure by a tumor is made upon the trachea for some time, a mucoid degeneration of the cartilage, with softening of the rings, results. After a sudden inspiratory effort the weakened cartilages may collapse and death from asphyxia follow.

A remote risk to the patient lies in injury to the parathyroid glands. If the technic of the operation, as described, is followed, there is no great danger of injuring these glands. C. H. Mayo believes that the risk is about as great as that of embolism following abdominal operations.

In considering the *curative value of the operation,* great difficulty is encountered because of the great variation in what different observers consider a cure. In a series of cases reported by Sorgo[87] the results regarding the individual symptoms are tabulated. His table includes 172 cases. Of these, the tremor entirely disappeared in 57.9 per cent., the tachycardia in 48.7 per cent., and the exophthalmos in 48.2 per cent. The general condition of the patient was practically normal in 30 per cent. of the cases. In about 25 per cent. of the others there was great improvement in the symptoms, but the patients could not be said to be cured of any. The operation mortality in these cases is 13.9 per cent. The results, as shown in the cases reviewed by von Eiselsberg, which include those reported by Mattisen,[88] Heyden-

[87] Sorgo. *Centralbl. f. d. Grenzgb. d. Med. u. Chir.*, May, 1898, Bd. I, No. 6, p. 329.

[88] Mattisen. *Inaugural Diss., Erlangen*, 1896.

reich,[89] Starr,[90] Schulz,[91] Buschan, Manheim,[92] and Sorgo, giving in all 1,223 cases, show complete recovery in 44.8 per cent., and great improvement in 23 per cent. The mortality in these cases was 8.3 per cent.

Friedhain[93] investigated the late results in 20 cases operated upon by Kümmell. These cases were examined from four and one-half to fifteen and one-half years after the operation. Of these, 14 were absolutely cured. Five, after periods varying from three and one-half to nine and one-half years, were found to be greatly improved and able to go about and continue their occupations, although all of the symptoms had not disappeared. One death resulted in this series, probably from hyperthyroidism, although necropsy did not reveal the cause.

With the improvement in technic the operative mortality and the percentage of cures have steadily improved up to the present time. Rehn, in 1900, reported 50 per cent. recoveries, with 22.1 per cent. mortality. Friedhain, 70 per cent. cures, with 5 per cent. mortality, in a series of 20 cases. Reviewing the reported cases from the clinics of Mikulicz, Krönlein, Kocher and König, he found, of the 105 cases reported, 75 cured (70.1 per cent.), 23 improved (21.9 per cent.), and 8 deaths (7.6 per cent.).

The Results of Partial Thyroidectomy for Exophthalmic Goitre.

The mortality of partial thyroidectomy for exophthalmic goitre runs, in the cases reported within the last two years by various operators, from 13 to about 6 per cent.

C. H. Mayo[94] reported, in 1908, 295 cases treated by partial thyroidectomy, with 18 deaths (6.1 per cent.), 7 of which occurred in the first 46 cases operated on by him. One death occurred on the table from shock, fifteen from acute thyroid intoxication—all within twenty hours after the operation. Two deaths resulted from embolism, one cerebral and one pulmonary.

INTRAGLANDULAR THYROID ENUCLEATION.

This operation, first practised by Porta and later extensively employed by Billroth, Wolff, Bruns and others, in the treatment of circumscribed simple goitre, has but a limited field of application in the treatment of exophthalmic goitre. It is applicable only to those cases

[89] Heydenreich. Semaine Méd., 1895, XV, p. 32.
[90] Starr. *Jour. of Nerv. and Ment. Dis.*, 1894; also Exophthalmic Goitre, Treatment, *Med. News*, 1896, Vol. LXVIII, pp. 421-529.
[91] Schulz. Cited by von Eiselsberg.
[92] Manheim. Cited by von Eiselsberg.
[93] Friedhain. *Arch. f. Klin. Chir.*, Bd. 77, p. 917.
[94] Mayo. *Surgery Gynecology and Obstetrics*, March, 1909, p. 237.

of goitre upon which symptoms of hyperthyroidism have been grafted and is not to be considered in the operative treatment of the type of goitre that is characteristic of primary Graves' disease. As we have shown, this type represents the more or less diffuse form of hypertrophy or hyperplasia of the thyroid gland. Although this form may appear as a unilateral goitre, yet the nature of the glandular enlargement does not permit of the enucleation of the tumor.

In adenoma, either pure or those having undergone the various metamorphoses common to these growths, and in cystic tumors, we have in this method the safest means of removing the tumor and reducing and favorably influencing the thyroid secretion that is the essential cause of the disease.

Technic. The incision is the same as for unilateral thyroidectomy, namely, the transverse collar incision of Kocher, or the angular incision, depending upon the size, position and form of the tumor. The incision includes the skin, fascia and platysma. The deep fascia is incised in the median line as in the operation for excision of the gland. The depressors of the larynx are either retracted or incised transversely, depending upon the location and size of the growth. The thyroid is exposed but not dislocated, as in thyroidectomy. Between the larger vessels of the capsule the cellular tissue and capsule are incised, with what gland tissue may exist, down to the tumor. The small vessels that are cut are caught and ligated. When the enveloping capsule of the growth is reached, the tumor is quickly but carefully separated from the capsule, either by means of the fingers or by Kocher's director. Hemorrhage at this stage of the operation is usually insignificant and can be readily controlled by temporarily packing the cavity left by enucleation of the tumor. Permanent hemostasis is best accomplished by closing the cavity by a suture of catgut.

After bringing together the edges of the cavity by suture of the gland tissue, no drainage is necessary, providing the hemostasis is effective and complete. The cut muscles and skin are reunited as in partial thyroidectomy.

The greatest danger in intraglandular enucleation is hemorrhage. In extremely vascular growths or in hypertrophy or hyperplasia, or in the so-called struma vasculosa, it goes without saying that this procedure should not be chosen, but systematic ligation of the thyroid arteries and excision of a half of the gland should be selected.

The advantages presented by this operation, under favorable conditions, are that it saves from injury the neighboring important structures, namely, the recurrent laryngeal nerve and the parathyroid glands, and that it does not by cicatrization and interference with blood supply expose to remote changes these delicate structures. It also

permits of a second operation on the same side or on the opposite side by conserving gland tissue.

The chief objection to its application to exophthalmic goitre or cases of hyperthyroidism is that by it we frequently do not remove sufficient secreting thyroid substance, and therefore do not control the excessive secretion that is the cause of the symptoms.

RESECTION-ENUCLEATION OF KOCHER.

This operation is occasionally employed by Kocher in the treatment of exophthalmic goitre. Like intraglandular enucleation, it has a greater field of application in simple goitre. It is, according to Kocher, chiefly of value in diffuse follicular colloid or cystic degeneration.

The various steps of the operation up to the point where the gland is exposed are the same as described under intraglandular enucleation. The isthmus is freed from the trachea, crushed and divided between two ligatures. The goiteroid mass is then freed by means of the fingers from the posterior surface of the gland, leaving the posterior portion of the gland and the glandular capsule intact. After separation of the tumor from the overlying gland tissue and the posterior portion of the capsule, the outer remaining pedicle, consisting of gland tissue and capsule, is crushed, ligated and incised. This procedure protects the recurrent laryngeal and the parathyroids.

Hemorrhage is controlled by suture ligature as in the enucleation operation. This method possesses the advantage of conserving considerable gland tissue, which is of great importance when both lobes are extensively diseased in diffuse cystic degeneration. This type of goitre is seldom associated with symptoms of excessive secretion.

INCISION AND DRAINAGE OF THE THYROID.

This operation is indicated only in large cystic goitres when repeated attacks of inflammation have caused dense adhesions of the cyst wall to the surrounding structures. The method of operating is as fololws[94]:

An incision is made over the most prominent part of the tumor down to the gland. The vessels of the capsule, both fibrous and glandular, are ligated and divided. The cyst wall is incised and the cut edges are sutured to the skin. From the cavity all colloid masses are removed with the fingers. The cavity is packed with gauze to control hemorrhage and facilitate drainage.

---

[94]Mayo. *Surgery, Gynecology and Obstetrics*, March, 1909, p. 237.

EXOTHYROPEXY IN GRAVES' DISEASE.

Exothyropexy, as practised by Jaboulay, consists in freeing the gland from its environs and dislocating it upon the surface of the skin, where it is allowed to remain. As a result of atrophy and resorption, the gland gradually shrinks and becomes cicatrized. This operation has been practised chiefly in France, and there by but a few surgeons. Following exothyropexy, symptoms of acute thyroid intoxication are frequently noted from the escape into the tissues of the secretion of the gland. An improvement in the most favorable cases is extremely slow.

Berard[95] mentions 12 cases operated upon by Jaboulay and Poncet. Of these, 7 were considerably improved, but none could be said to be cured, although later other surgical procedures, such as excision, enucleation and sympathectomy, were more easily performed and cured the patients.

In the 12 cases operated upon there were 2 deaths from acute hyperthyroidism following the operation. In this country exothyropexy has not been practiced, and is not generally sanctioned by the profession.

The principal objection to this operation is the difficulty in dislocating the gland, particularly when the goitre is large and deep-seated. Dyspnea and venous hemorrhage are frequent, and constitute the greatest risk to the patient. Healing is slow and frequently accompanied by septic infection. Finally, the deformity resulting is great and the cures infrequent.

Technic. A vertical incision along the median line of the neck from the larynx to the episternal notch is carefully made through the skin and fascia down to the cellular space between the sterno-thyroid muscles. Retraction of these muscles from the median line exposes the fibrous capsule of the gland. Each thyroid lobe is then separated anteriorly from its capsule by means of the fingers until the margins of the gland are reached. If retraction of the muscles does not give sufficient room, the muscles, fascia and skin are incised. Each lateral lobe is now drawn forward by hooking the fingers underneath its external border and lifting it out of the wound. Occasionally both lobes may be dislocated simultaneously. This, however, is dangerous because of the risk of compression of the trachea. The glandular capsule should never be penetrated.

Strips of gauze are now packed about the gland to protect the wound from contact with the secretion of the gland and to prevent

---

[95]Berard. *Thérap. Chirurgicale du Goitre*, 1897; also, Berard, Le Denton and Delbet. Corps Thyroide, *Traité de Chirurgie*, Vol. XX, 1908, p. 398.

the gland from being drawn back into the incision. The skin is allowed to unite with the gland and to gradually cover it. Great care is necessary in preventing infection during the process of cicatrization, which, on an average, requires two months.

LIGATION OF THYROID ARTERIES.

This operation, as with the other operations mentioned, was first

Fig. 957.
Exothyropexy in Graves' Disease.

practised in the treatment of simple goitre. Its application to exophthalmic goitre was first recommended by Mikulicz[90] and Kocher.

Various operators have advised the ligation of one or more thyroid vessels in extreme cases as a preliminary step where later exci-

[90] Mikulicz. *Verhand. der Deutschen Gesellschaft f. Chirurgie*, 1895, 24th Congress, p. 21

sion is to be practised if the patient's condition will warrant this operation. At the present time the operation is seldom practised excepting as a means of preparing the patient for a more radical operation. Under these circumstances one or both superior thyroid arteries, with the accompanying veins, are ligated, either by isolation of the vessels or

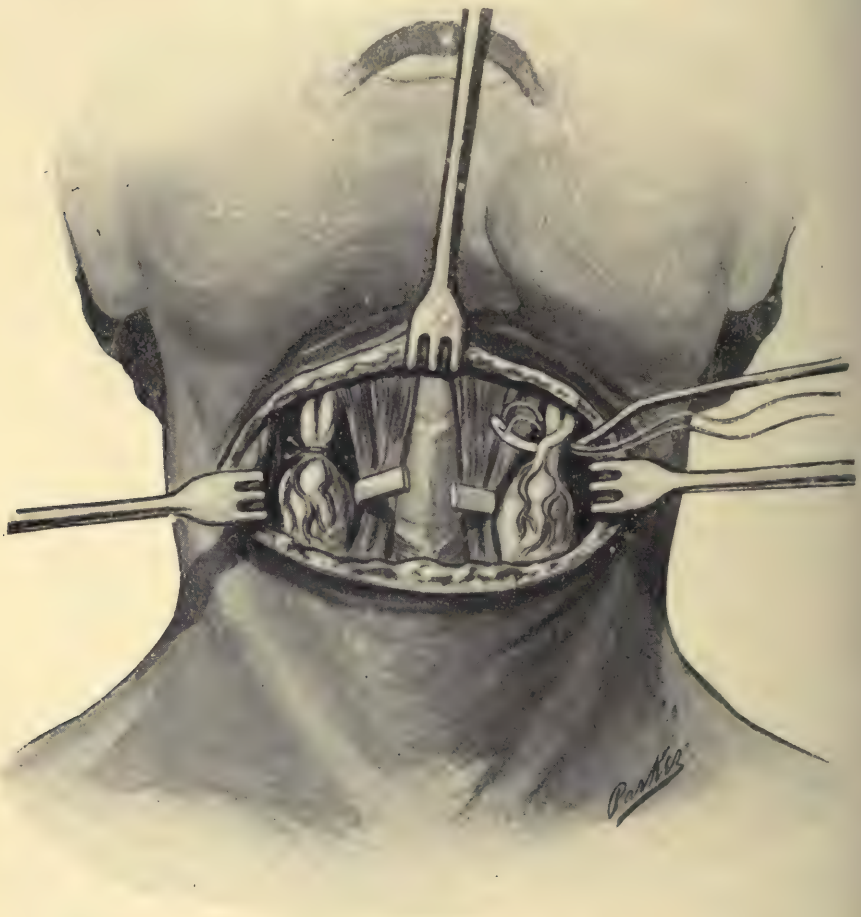


Fig. 958.

Mayo's Incision for Ligation of the Superior Thyroid Arteries in Exophthalmic Goitre.

by including it in a mass ligature applied to the superior pole of the gland. As a curative operation, ligation of two vessels is not to be considered. The ligation of three vessels, two superior and one inferior, may sufficiently control the circulation to cause atrophy of the gland, but the dangers of this operation are as great as those of

partial resection, and the chances of effecting a cure considerably less. Even ligation of the superior thyroids alone in extreme cases of Graves' disease is not free from danger.

Rehn[97] mentions 20 cases in which he ligated from one to three vessels, with a mortality of 20 per cent. Of these, only 5 were cured and 10 slightly improved.

When after extirpation of one lobe the symptoms persist, indicating that sufficient gland tissue has not been removed to effect a cure, ligation of the opposite superior thyroid vessels may be considered. Kocher strongly recommends this procedure under these conditions.

In patients in whom the disease is not too far advanced, the danger associated with ligation of the superior thyroid alone is, in my opinion, very small. The operative mortality in 97 cases of double ligation, reported by C. H. Mayo,[98] was one. In fourteen cases the superior thyroid on the side remaining after extirpation of a lateral half gave no mortality.

The same operator reports later[99] 225 cases of ligation of the thyroid artery with a mortality of 2 per cent. The curative value of the procedure was considered in this paper. The results were as follows:

There was slight improvement in 9, great improvement in 44, very marked improvement in 11, absolutely cured, 4, no improvement, 9. In the majority of these cases the operation was made as a preliminary step to removal of a part of the gland.

Technic of the Ligation of Both Superior Thyroid Arteries.

Kocher's skin incision transversely across the neck, on a level with the lower border of the thyroid cartilage, slightly curved, with convexity downwards and the extremities of the incision carried vertically upwards for a short distance along the anterior border of the sterno-mastoid. After division of the skin, platysma, the sterno-mastoid is retracted outwards, exposing the lower border of the larynx and the omo-hyoid, which is pulled upwards and toward the median line. The superior pole is isolated. The superior thyroids are found just above the omo-hyoid muscle, are isolated and doubly ligated.

If the ligature is thus applied, the superior or recurrent laryngeal nerves are not likely to be injured, as the field of operation lies between these two structures.

---

[97] Rehn. *Mitt. a. d. Gr. d. Med. u. Chir.*, Bd. 7, p. 169.

[98] Mayo. *Surgery, Gynecology and Obstetrics*, March, 1909, p. 237.

[99] Mayo. Vessel Ligation for Hyperthyroidism. *Annals of Surgery*, Dec 1909, Vol. 50, p. 1018.

LIGATION OF THE SUPERIOR POLES OF THE GLAND.

This operation has been practised by Jacobson,[100] of Toledo, in the treatment of exophthalmic goitre. The theory upon which the operation is based is met by including in the ligature both arteries and veins and, in addition, a considerable part of the poles of the gland, that not

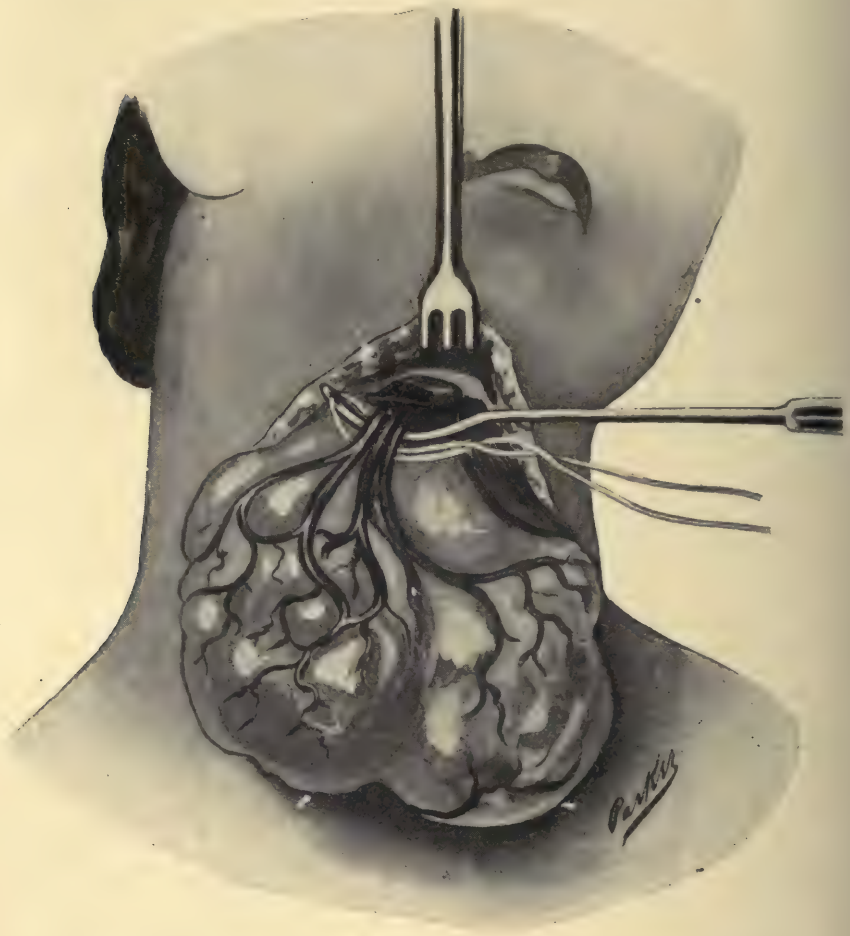


Fig. 959.

Unilateral Thyroidectomy. Ligation of the Superior Thyroid Vessels after Dislocation of the Gland.

only is the blood supply to the gland lessened, but the escape of thyroid secretion into the circulation is prevented by occlusion of the lymphatic vessels of the gland. Jacobson reported 8 cases operated

[100]Jacobson. Cited by Ochsner. *Thyroid and Parathyroid Glands.*. 1910, p. 163.

upon by this method, with 1 death. The immediate effect of the operation seems to be about as satisfactory as ligation of both superior thyroids after the method of Mikulicz and Kocher. The ultimate results cannot be compared with those of other operative methods because of the comparatively short time that the cases were under observation.

Jacobson's technic is similar to that employed by Rydyger[101] for ligation of the superior thyroid arteries.

The superior pole of the gland is reached through a short vertical incision to the inner side of the sterno-mastoid muscle, directly over the upper pole of the gland. The sterno-mastoid is retracted outwards and the sterno-thyroid inwards, exposing the capsule of the gland, which is now incised. By means of a large aneurysm needle two strong ligatures of silk or linen are passed about the exposed portion of the gland, one and a half centimeters apart, and tightly tied.

The exact stages of this operation are thus described (Surgery, Gynecology and Obstetrics, Nov., 1910, p. 510), by the writer.

"The method consists in doubly ligating both upper horns of the thyroid gland and is carried out as follows: After carefully palpating and determining the position of the upper pole of the right lobe, either a transverse or an oblique skin incision is made directly over it. The incision is one and one-half inches long and extends through the skin, superficial fascia, platysma, down to deep fascia, when the inner border of the sterno-mastoid muscle can be seen. The inner border of the sterno-mastoid is then loosened, raised and retracted, exposing the fibers of the sterno-thyroid muscle which run in the opposite direction to those of the sterno-mastoid. These fibers are separated for about one inch, the deep fascia covering the thyroid will then be exposed. This fascia is next divided, and the capsule of the gland brought into view. The muscles are well retracted by blunt hooks. A litigature carrier or a large curved pedicle or aneurism needle is used to pass the ligatures. The material used for ligation has been mostly linen or silk. Theoretically it seems that heavy black linen on account of its slowness of absorption is best.

In passing the ligature around the upper pole on the right side, the blunt needle is passed from within out, while upon the left it is passed from without in, after first freeing and raising the pole somewhat by blunt dissection.

Theoretically at least, it seems that the ligatures should be placed extra-capsular, for the reason that the lymphatic vessels of the gland parenchyma empty into the lymphatics contained within the capsule, and

[101] Rydyger. *Arch. f. Klin. Chir.*, Bd. 40, p. 806.

that the extra-capsular ligature will more effectually stop the gland excretion.

Some little resistance may be encountered in passing the blunt needle about the pole; this, however, is quickly overcome. When the blunt point of the needle has been passed, the ligature is grasped and the instrument withdrawn. By cutting the loop, we have two ligatures surrounding the gland pole. These are carefully separated and tied, leaving a space between them of from one-fourth to one-half inch. Immediately after ligation the gland tissue in the vicinity of the ligature becomes blanched.

The closure of the wound consists in the approximation of the muscles by one or two interrupted catgut sutures, followed by approximation of superficial fascia and skin.

The operation of "pole ligation" may be used in combination with other operations on the thyroid gland for the relief of exophthalmic goiter. It may be used in conjunction with the pressure atrophy operation of Werelius, with partial thyroidectomy in which the ligation of the pole is made on the remaining lobe, and also in combination with ligation of one or both inferior thyroid arteries."

Aside from the possible advantage of including in the ligature gland tissue, blood and lymphatic vessels, this procedure has to recommend it simplicity and freedom from any great risk to the patient. It can usually be performed under local anesthesia and at the hands of a skilful operator should consume only a few moments. The chief danger lies in injury to the internal jugular vein or the carotid artery.

OPERATIONS UPON THE CERVICAL SYMPATHETIC.

In discussing the treatment of exophthalmic goitre by operative measures directed against the cervical sympathetic, the stretching operation may be left out of consideration. The effect of simple section of the sympathetic cord has also but slight, if any, influence on the disease. This operation was first proposed by Edmonds.[102] Jaboulay[103] reported six cases of unilateral and two of bilateral section of the sympathetic cord. In all the retraction of the eye became noticeable after the first day. The size of the goitre was lessened and the heart symptoms were somewhat improved. The pulse rate was not materially changed, but the heart's action became more regular and the tones clearer. One patient observed four years after the operation was greatly improved in health.

The results of partial resection, including both unilateral and bi-

---

[102]Edmonds. *Path. Soc., London*, 1895, May 21st, p. 224.

[103]Jaboulay. Cited by Jonnesco. *Tr. 12th International Med. Cong.*, p. 515.

lateral operations, are, on the whole, more favorable than those obtained by simple section.

Balascescu[104] reports from Jonnesco's clinic 27 cases treated by partial resection. These cases were observed from one to four years.

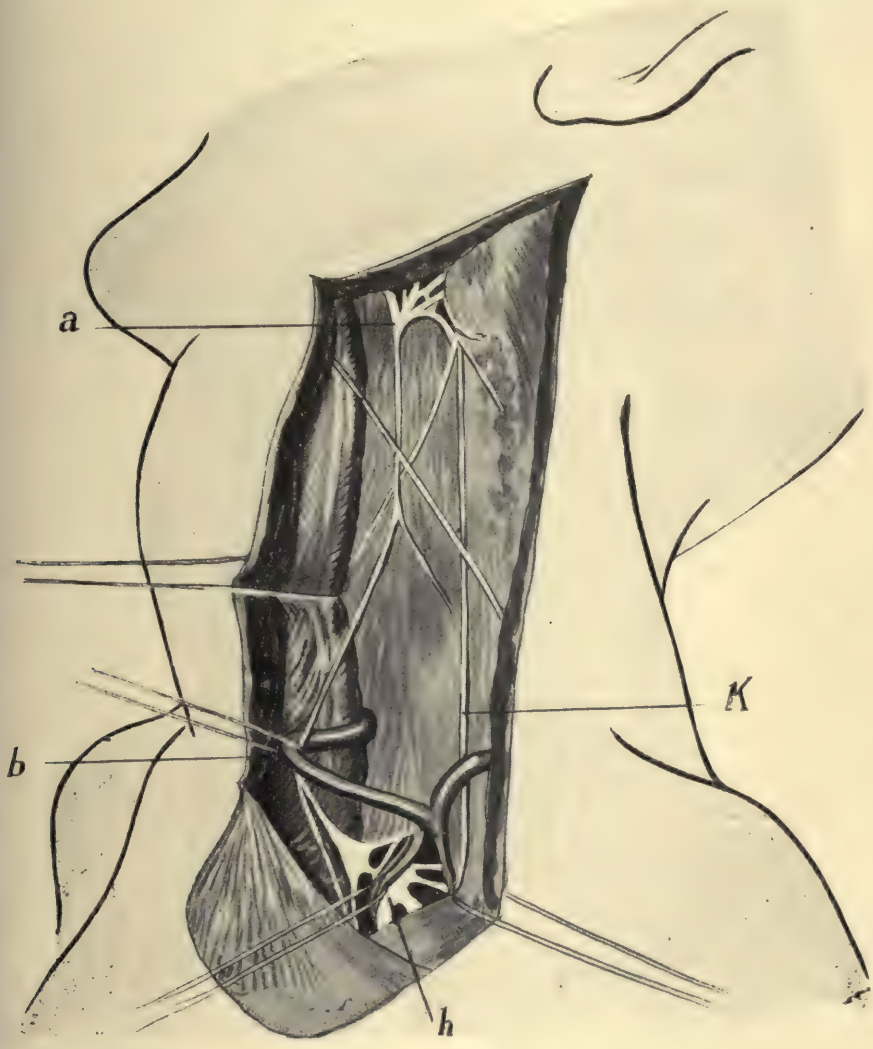


Fig. 960.

The Cervical Sympathetic Nerve and Ganglion.

a, Superior Cervical Ganglion.
b, Inferior Thyroid Artery.
K, Phrenic Nerve.
h, Middle Cervical Ganglion.

[104]Balascescu. *Arch. f. Klin. Chir.*, Bd. 67, p. 59.

Of these, 9 were cured, 11 improved, and 2 unimproved. There were five deaths. The same author reported 17 cases of total bilateral sympathectomy. Of these, 14 were operated upon by Jaboulay. Of the 17 cases reported by Balascescu, 10, or 58.9 per cent., recovered completely, the exophthalmos being the first to disappear. Improvement of the tachycardia was not so rapid nor, in general, so satisfactory as that of the first-named symptom. In some cases the pulse quickly reached the normal and so remained. In two cases the tachycardia re-

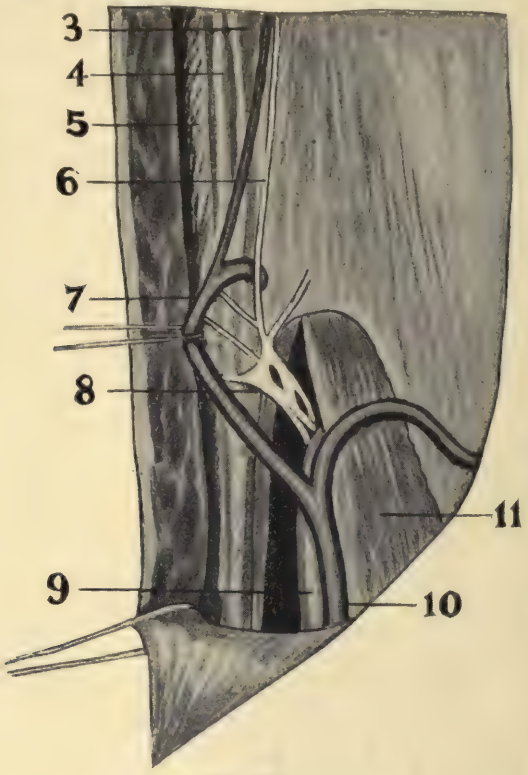


Fig. 961.

The Middle Cervical Ganglion. (After Bryant).

3. Common Carotid Artery.
4. Pneumogastric Nerve in Sheath.
5. Internal Jugular Vein.
6. Sympathetic Cord.
7. Inferior Thyroid Artery.
8. Middle Sympathetic Ganglion.
9. Thyroid Axis.

appeared after the pulse rate had been normal for some time. In five of the seventeen there was great improvement either in the exophthalmus, the general nervous manifestations, or in the tachycardia, although the patients could not be considered cured.

Curtis,[105] of New York, reported 7 cases of sympathectomy for exophthalmic goitre. Of these, 3 died, 2 from acute hyperthyroidism and 1 from the anesthetic. Of the 4 cases that survived the operation, one relapsed within nine months and died ultimately of an acute endocarditis. One case had greatly improved at the end of one year, but died of nephritis. One was completely cured at the end of five years, and one was improved. These results were so discouraging that Curtis abandoned the operation and advised partial thyroidectomy when an operation was to be considered. In reporting the cases he mentions as contraindicating this operation the unsightly scars, the high mortality and the uncertainties of relief that have attended this procedure.

The death rate, according to Rhem,[106] in total resection is 9.3 per cent. This, when compared to the mortality rate in unilateral resection of the thyroid for exophthalmic goitre, argues strongly in favor of the latter operation.

In considering the relative merits of the two procedures we must strongly advise partial thyroidectomy in preference to any operation on the sympathetic. Total resection is an operation, in my opinion, many times more difficult and offering less hope of curative results than operations on the thyroid gland, particularly excision of a portion of the gland or ligation of the thyroid arteries. One of the strongest arguments against sympathectomy is that it has never been popular with surgical masters; that the theory upon which these procedures are based never has been accepted as adequately explaining the phenomena of the disease.

Technic of Total Unilateral Sympathectomy

Anatomical Considerations. The superior ganglion, the largest of the three, is generally found opposite the second and third vertebrae, although it may be as low as the fourth. It lies behind the carotid sheath and rests upon the rectus capitus anticus major muscle. The inferior ganglion lies between the base of the transverse process of the seventh cervical vertebra and the neck of the first rib, deep in the root of the neck. It is in relation with the superior intercostal artery internally. Externally, it is in intimate relation with the vertebral artery, which it invests with its branches. The middle ganglion, which is the smallest, is frequently but a slight fusiform enlargement of the cord opposite the sixth cervical vertebra, and in close relation to the inferior thyroid artery from which it derives the name of the thyroid ganglion. The cervical cord is in close relation to the vagus, de-

[105] Curtis. *Annals of Surgery*, Vol. 43, p. 336.
[106] Rhem. *Mitt. a. d. Grenzgeb. der Med. und Chir.*, Vol. 37, p. 165.

scending branch of the hypoglossal and below with the phrenic nerves. Superficial to the cord and crossing it about the middle of the neck is the spinal accessory.

The Operation. The patient is placed on the table with the head and shoulders slightly elevated. The head is allowed to hang over a pillow placed underneath the neck and shoulders, and the face is turned toward the side opposite to the one to be operated upon.

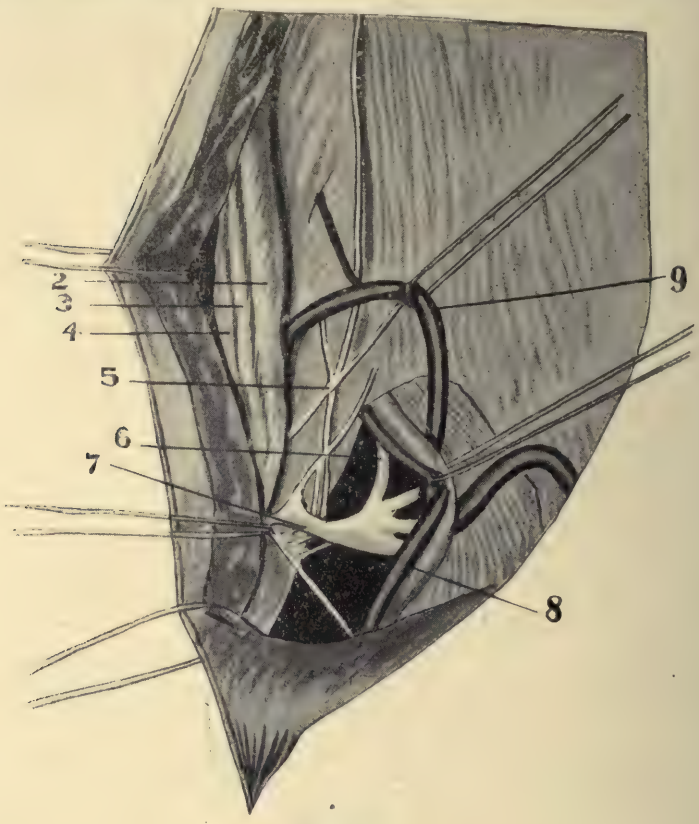


Fig. 962.

Inferior Cervical Ganglion. (After Bryant).

2. Common Carotid Artery.
3. Pneumogastric Nerve.
4. Internal Jugular Vein.
5. Middle Cervical Ganglion.
6. Vertebral Nerve.
7. Inferior Cervical Ganglion.
8. Vertebral Artery and Vein.
9. Inferior Thyroid Artery.

An incision is made beginning at the lower and posterior part of the mastoid, running parallel with the posterior border of the

sterno-mastoid muscle, down to a point on a level with the lower border of the clavicle. This is carried through the skin and superficial fascia and platysma to the superficial lamina of the deep cervical fascia which forms the anterior layer of the sheath enclosing the sterno-mastoid muscle. The external jugular is caught between tissue forceps and cut between these. The deep fascia is incised close to the posterior border of the sterno-mastoid and the muscle retracted forward. Care is taken not to injure the spinal accessory nerve. Upon retraction of the muscle inward, with the common sheath of the carotid artery and jugular vein, the sympathetic cord is sought for about the middle of the wound. It will be found posterior to the sheath of the vessels resting upon the longus colli and scalenus anticus muscles. Internally, it is in relation with the pneumogastric nerve, from which it must be differentiated. The sympathetic is recognized by tracing it upwards to the superior cervical ganglion. The ganglion is now isolated, its communicating branches divided, and with the cervical cord dissected downwards. As the lower angle of the wound is reached the cord is drawn tense and the middle ganglionic enlargement freed from the inferior thyroid. At this stage of the operation I have found that division of the sterno-mastoid muscle through its tendinous lower end greatly facilitates this step, as it also does the succeeding steps of the operation. Continuing downwards, while making gentle traction on the nerve trunk, the lower ganglion is reached behind the neck of the first rib. The vertebral artery and vein are isolated and with the scalenus anticus muscle are retracted outwards. Above, the inferior thyroid is at this time in danger of being injured. This is avoided by gentle retraction of that vessel inwards and upwards. With the sterno-mastoid divided the ganglion is found without great difficulty by tracing downward the sympathetic cord. Its branches of communication are divided with a blunt scissors and the ganglion removed.

The wound is closed without drainage after uniting the divided sterno-mastoid with deep sutures of catgut and the skin with silkworm gut.

The chief danger of the operation is from injury to the large veins of the neck, with consequent hemorrhage or air embolism. A clear conception of the anatomical structures that are in relation with the operative tract will enable the operator who has at his command the necessary dexterity to avoid injuring these important structures. Injury of the pneumogastric and phrenic nerves, though not necessarily followed by serious consequences, may be a source of trouble both to the operator and the patient and must be avoided. The pneumogastric is distinguished from the cervical cord by its greater size

and by its more intimate relation to the carotid artery and jugular vein. A slight enlargement of the pneumogastric trunk that frequently is seen near the level of the third cervical vertebra may at first cause some confusion to the operator.

The removal of the superior ganglion alone with the sympathetic cord down to the middle ganglion is an operation that presents no great technical difficulties, and from this standpoint is of slight importance.

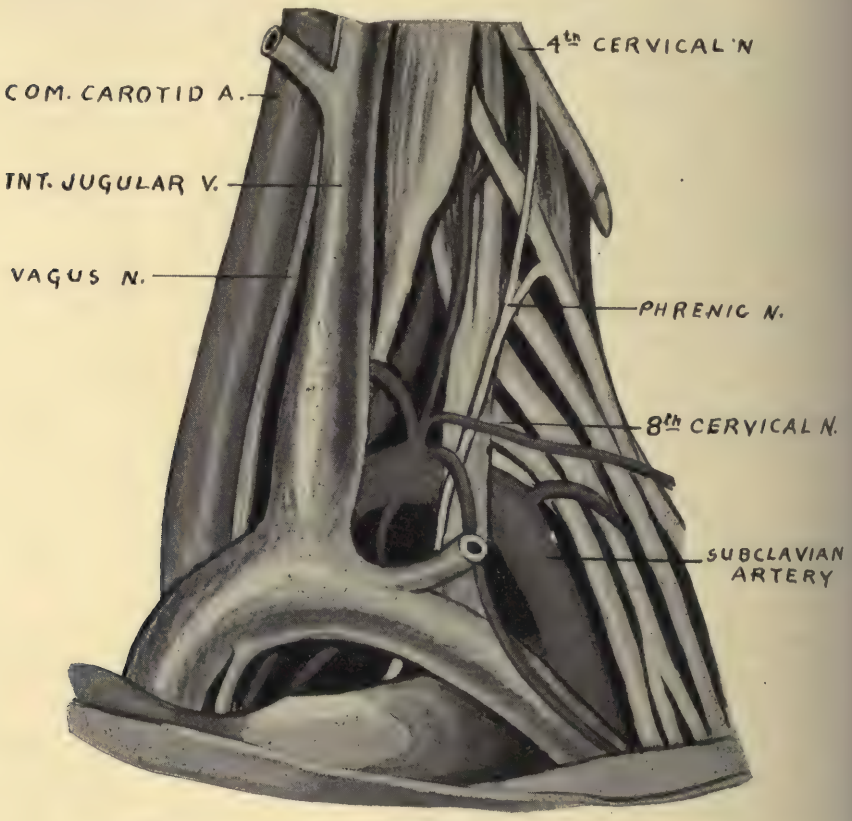


Fig. 963.

The Relations of the Structures Concerned in Removal of the Third Cervical Sympathetic Ganglion.

In *chronic glaucoma,* resection of the upper cervical ganglion has been long considered of value by ophthalmologists. I have operated upon 6 cases of this class. Five were performed at the Illinois Charitable Eye and Ear Infirmary. The operation is easily performed, and is not associated with any great risk to the patient. The technic is the same as employed in the first steps of the operation for com-

plete sympathectomy. The incision is carried along the posterior border of the sterno-mastoid as far as the clavicle. The muscle is not divided. The question of cervical sympathectomy for glaucoma is considered in another chapter.

What is known as *"pulsating exophthalmus"* is an affection in which we have three prominent symptoms, namely, exophthalmos, pulsation of the eye-ball and associated orbital structure, and a *bruit*. Other terms employed in describing this condition are "aneurysmal proptosis," and "vascular protrusion of the eye."

Fig. 964.

Case of Bilateral Pulsating Exophthalmos due to a Basal Skull Fracture. Loss of the Left Eye from Infection, as a Consequence of Extreme Exophthalmos and Corneal Anesthesia. Moderate Degree of Exophthalmos of Right Eye with Loss of Vision. Recovery after Ligation of the Common Internal and External Carotids and Superior Thyroid Arteries on the Left Side. Case Operated on by the Author at St. Luke's Hospital, Chicago, November 10, 1910.

Keller insists that the term pulsating exophthalmus be limited to those cases in which a communication exists between the cavernous sinus and internal carotid artery, although we now know from studies made at autopsy that other conditions may result in producing the classical symptoms of this affection.

Treatment of Pulsating Exophthalmus.*

The operative measures that have been employed in the treatment of pulsating exophthalmus are, (1) ligation of the common carotid on the affected sides; (2) ligation of both common carotids; (3) ligation of the internal carotid on the affected side; (4) ligation of both internal and external carotids on the same side; (5) ligation of the common external carotid and superior thyroid arteries on one side; (6) orbital operations, as (a) ligation of superior opthalmic vein; (b) ligation of pulsating veins at the inner angle of the orbit with excision of the varices that are a common accompaniment of this condition.

In a case operated on by me at the St. Luke's Hospital, October

Fig. 965.

Pulsating Exophthalmos. Case of Author's Operated on, October, 1909, at St. Luke's Hospital, Chicago. Recovery after ligation of the internal carotid artery.

14, 1909,[107] the internal carotid alone was ligated. Immediate cessation of the pulsation and bruit, with later retraction of the eyeball, followed. There were no untoward after-effects and the patient has been free from both objective and subjective symptoms up to the present time.

Orbital Operations for Pulsating Exophthalmus.

The relief from pulsating exophthalmus by orbital operations

*See, also, the chapter on Operations on the Orbital Walls and Contents.

[107]Halstead. Reported in *Surgery, Gynecology and Obstetrics*, Jan., 1910, p. 55.

alone can only be accomplished in those cases in which the altered tissues lie within the orbit, or in cases where an aneurysm of the carotid, by pressure upon the ophthalmic vein, is the cause of this condition. Where there is an aneurysmal varix, which, as we have shown, constitutes the essential cause in about 70 per cent. of the cases, no intra-orbital operation alone will relieve the patient.

One of the chief symptoms is pulsation with dilatation of the ophthalmic vein. When this results from pressure upon the vein by an aneurysm of the carotid, ligation of the vein just before it enters the sphenoidal fissure may relieve the objective symptoms of pulsation and exophthalmus, but cannot remove the subjective symptoms occasioned by the aneurysm, nor cure the disease. In the cases treated by ligation of the angular vein[108] and of the ophthalmic vein, by Noyes,[109] we must assume, in the absence of any anatomical data, that the symptoms were not the effect of an arterio-venous aneurysm involving the carotid and the cavernous sinus. In Noyes' case his description fits more accurately an arterio-venous angioma involving the ophthalmic artery and vein than it does an arterio-venous aneurysm of the carotid. His success in curing the disease by ligation and excision of the pulsating dilated vessels of the orbit he attributes to a thrombus forming and extending back to the sinus, closing the opening into the aneurysmal sac.

These operations on orbital vessels have been successful in the hands of others, both as primary operations and as secondary, and performed either at the time of the ligation of the carotid or subsequent to it, in cases where the ligation of the carotid did not immediately effect a cure.

In a case reported by Boden,[110] five months after bilateral ligation of the carotid the ophthalmic vein was ligated with success.

In the cases where the symptoms are the result of an aneurysm of the ophthalmic artery, it goes without saying that proximal ligation of the artery, if this operation can be successfully performed, will give the best results. Distal ligation, when the proximal operation is not possible, will in a relatively small proportion of the cases prove successful.

Technic of Ligation of the Common Carotid.

The seat of election for ligation of the common carotid is above the omo-hyoid muscle. The patient is placed upon the table with the head and shoulders elevated by means of a pillow placed between the

---

[108] Higgins. *Trans. Ophth. Soc. U. K.*, XXVIII, 1907, p. 187.

[109] Noyes. Pulsating Exophthalmus, *Trans. Am. Ophth. Soc.*, Vol. III, pt. 2, 1881, p. 308.

[110] Boden. *Deutsch. Arch. f. Klin. Chir.*, Bd. 51, p. 605.

shoulders. The chin is drawn up and turned away from the seat of operation. An incision, three and one-half inches in length, is made, with the center corresponding to the cricoid cartilage, along the anterior border of the sterno-mastoid muscle. This extends through the skin, platysma and the deep fascia, enclosing the sterno-mastoid muscle. The superficial veins, including the external jugular, are caught before being incised and then divided and ligatures applied. When the fascia enclosing the sterno-mastoid is reached, it is grasped with a Kocher forceps and pulled forward. It is then incised in the

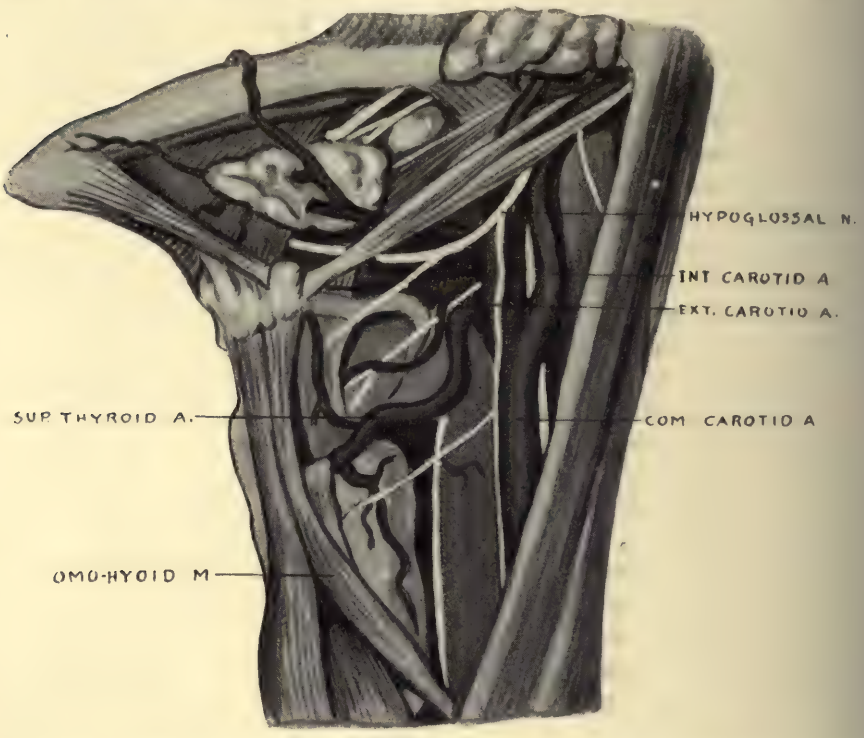


Fig. 966.

The Relations of the Common, External and Internal Carotids to the Superior Thyroid and other Neighboring Structures.

direction of the skin incision, though not to the same extent. The sterno-mastoid is retracted slightly outwards and the omo-hyoid downwards, exposing the internal jugular with the descending branch of the ninth nerve. The sheath of the fascia enclosing the vessels is now opened and the jugular vein drawn outwards from the artery. The artery is freed from the surrounding structures by a Kocher director, armed with a catgut ligature, passed underneath the artery from without inwards, the ligature secured and the director withdrawn.

Two ligatures are thus passed about the vessel and tied, one centimeter apart. The ligatures are tied tight enough to occlude the lumen. No effort is made to crush the vessel wall. If thought desirable, the vessel may by means of an artery forceps be crushed between the ligatures or divided. This last act is unnecessary. The structures that must be avoided are the internal jugular vein, the pneumogastric and descendens hypoglossi nerves.

Fig. 967.

Dissection showing the Relations of the Common Carotid to the Omo-hyoid Muscle.

The wound is closed by reuniting the fascia over the vessels with a fine catgut suture and the skin by silkworm gut. The wound is dressed in the way we have described and the patient placed in bed with the head elevated.

Ligation of the Internal Carotid.

An incision is made so that both internal and external carotids

are exposed just above the bifurcation of the common carotid. This extends along the anterior border of the sterno-mastoid from the angle of the jaw to the middle of the neck, the center corresponding to a point on a level with the upper border of the thyroid cartilage. The vessels are exposed by drawing the sterno-mastoid outwards and the digastric muscle upwards. The external carotid should be drawn inwards, as in this part the internal carotid lies outside and rather behind the external. The ligature is passed on a Kocher's director from

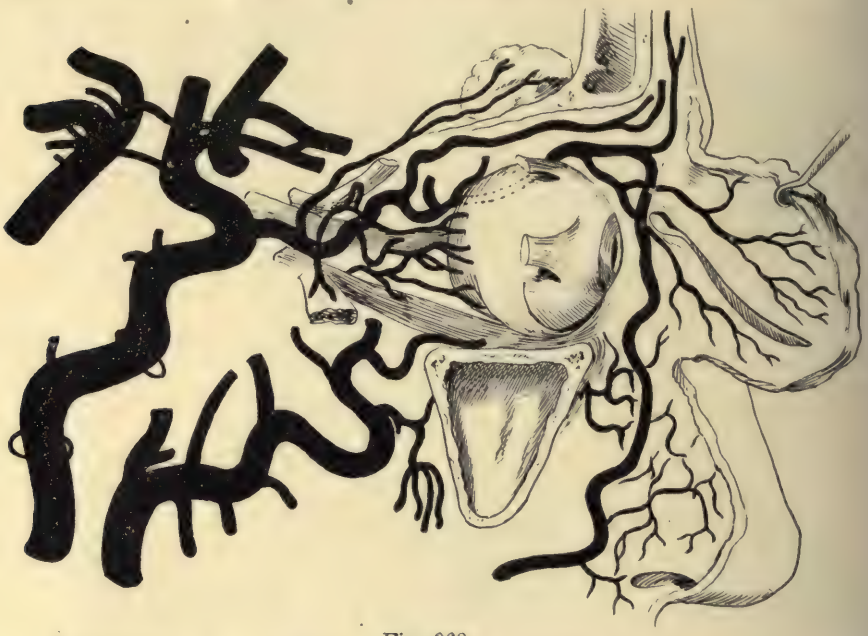


Fig. 968.

Relations of the Carotid Arteries and Jugular Veins to the Ocular Region.

without inwards, avoiding the internal jugular vein and the pneumogastric nerve.

The External Carotid may be ligated through the same incision, and in the same manner as the internal carotid.

The author wishes to express his gratitude to Dr. Roger T. Vaughan, Adjunct Attending Surgeon and First Assistant in the Surgical Clinic of St. Luke's Hospital, Chicago, for his valuable assistance in the preparation of this chapter.

LIST OF ILLUSTRATIONS.

PART I.

BIOGRAPHICAL SKETCH OF SOME REPRESENTATIVE OPHTHALMIC SURGEONS.

Page

Fig. 1. Surgical and Ophthalmic Instruments Found in Upper Egypt. (M. Meyerhof, Cairo, Egypt) 19
Fig. 2. Votive Tablet Representing a Pair of Eyes, with the Inscription, "Philematin Dedicated [This] as a Votive Offering" 20
Fig. 3. Pterygotome (Milne) 21
Fig. 4. Depression Needle (Milne) 21
Fig. 5. Epilation Forceps (Milne) 21
Fig. 6. Ancient Greek Medical Vases (Simpson) 22
Fig. 7. Ancient Roman Medicine-Stamps (Simpson) 23
Fig. 8. Couching of Cataract (Bartisch) 25
Fig. 9. Jacques Daviel 28
Fig. 10. Reproduction of Daviel's Sketch, Showing the Instruments Employed by Him in Making His First Cataract Extraction 29
Fig. 11. Albrecht von Graefe 30
Fig. 12. William Cheselden 31
Fig. 13. Joh. Reimarus 33
Fig. 14. Joh. Schmidt 34
Fig. 15. Thomas Young 35
Fig. 16. Herman von Helmholtz 39
Fig. 17. E. C. Donders 40

PART III, CHAPTER I.

THE DEVELOPMENT OF OPERATIVE SKILL ON THE PART OF THE SURGEON.

Fig. 18. Vienna Mask 184
Fig. 19. Eye Clamp for Vienna Mask 185
Fig. 20. The Phantom Face 186
Fig. 21. Home Made Cigar Box Mask. (Veasey) 187
Fig. 22. Correct Way to Hold the Linear Knife, with the Ends of the Fingers and Handling It with the Forward and Backward Movement of the Fingers 189
Fig. 23. Correct Way to Hold the Linear Knife, with the Ends of the Fingers. Knife Has Been Slightly Thrust Forward by the Movement of the Fingers. (Landolt) 190
Fig. 24. Incorrect Way of Holding the Linear Knife. (Landolt) 191
Fig. 25. Correct Way of Holding the Scissors. (Landolt) 192
Fig. 26. Correct Way of Holding the Scissors. (Landolt) 193
Fig. 27. Incorrect Manner of Holding and Handling the Scissors. (Landolt) 194
Fig. 28. Incorrect Way of Using the Scissors. (Landolt) 195
Fig. 29. Correct Way of Holding the Spatula, Spoon or Curette 196
Fig. 30. Incorrect Way of Holding the Spatula, Spoon or Curette 197
Fig. 31. Mellinger's Eye Speculum 200
Fig. 32. Fisher's Lid Elevator 201
Fig. 33. Elschnig's Straight Forceps 202

PART III, CHAPTER II.

THE PREOPERATIVE TECHNIQUE OF OPHTHALMIC SURGERY.

Page

Fig. 34. Cap for Confining and Protecting Patient's Hair Before and During Operation 212
Fig. 35. Undine for Washing Out Conjunctival Sac 214
Fig. 36. Porcelain Jar with Rubber Tube and Glass Nozzle Attachment for Washing Out Conjunctival Sac 215
Fig. 37. Face Covering with Aperture Over Field of Operation and Lawford's Speculum in Position 216
Fig. 38. Cap and Gown Put On by Surgeon Before Personal Sterilization 218
Fig. 39. Sterile Apron, Cap and Face Mask Donned by the Surgeon 218
Fig. 40. Surgeon's Wire Cap, Face Mask and Sterile Gown 220
Fig. 41. Surgical Attire, with the Exception of the Shoes 220
Fig. 42. Nurse's Cap and Gown 222
Fig. 43. Outline Drawing of Material for Nurse's Cap 223
Fig. 44. Nurse's Cap Complete 224
Fig. 45. Nurse Completely Dressed in Cap, Mask, Gown and Gloves 225
Fig. 46. McNaughton Jones' Modification of Liebreich's Eye Dropper 228
Fig. 47. Snellen's Collyrium Bottle and Dropper 229

PART III, CHAPTER III.

THE AFTER-TREATMENT OF OPHTHALMIC OPERATIONS AND OF THEIR COMPLICATIONS.

Fig. 48. Halstead's Mosquito Forceps 237
Fig. 49. Snellen's Lid Clamp 238
Fig. 50. Price's Suture Plate 240
Fig. 51. The Interrupted Suture 240
Fig. 52. The Continuous Suture 241
Fig. 53. Tension Suture 241
Fig. 54. Smooth Pointed Forceps for Removing Sutures 242
Fig. 55. Monocular Eye Bandage 244
Fig. 56. Binocular Eye Bandage 245
Fig. 57. A Simple Single-Turn Bandage 246
Fig. 58. Monocular Dressing with Adhesive Plaster 247
Fig. 59. Monocular Dressing with Adhesive Plaster 248
Fig. 60. Binocular Dressing with Adhesive Plaster 249
Fig. 61. Fixation of Lids with a Vertical Strip of Isinglass Plaster 250
Fig. 62. Patch of Black Felt for Retaining Dressing and Protecting the Eye 251
Fig. 63. Ring's Mask 252
Fig. 64. Single Wire Mask 253
Fig. 65. Double Wire Mask 254
Fig. 66. Metal Plate Incorporated in Eye Dressing 255
Fig. 67. Cotton Spindles for Sponges 256
Fig. 68. Gauze "Bird Nest" Sponges. (Beard) 257
Fig. 69. Method of Wrapping Cotton to Make an Applicator. (Beard) 258
Fig. 70. The Way in Which Cotton, Wrapped as Shown in Previous Figure, Spreads Out to Form a Brush When Wet 259
Fig. 71. Method of Wrapping Cotton to Make Applications of Acids and Caustic Solutions. (Beard) 260
Fig. 72. Allport's Treatment and Dressing Tray for Bedside Use 262
Fig. 73. "Ear and Ulcer Syringe," for Irrigating Eye 263
Fig. 74. Undine, for Irrigation 264
Fig. 75. Todd's Irrigator 265
Fig. 76. Another Form of Irrigator 266
Fig. 77. Dropper Fitting Into Mouth of Bottle 267
Fig. 78. Leiter's Coil for Hot or Cold Applications 267
Fig. 79. Artificial Leech 268
Fig. 80. Galvano-Cautery Handle for Use in Ophthalmic Surgery 273

Page
Fig. 81. Galvano-Cautery Points for Use in Ophthalmic Surgery..... 274
Fig. 82. Wordsworth-Todd Cautery..... 274

PART III, CHAPTER IV.

ELECTRIC APPLIANCES AND THEIR USE IN OPHTHALMIC SURGERY.

Fig. 83. Electro-Cautery 285
Fig. 84. Cautery Points..... 286
Fig. 85. Method of Using the Electro-Cautery..... 287
Fig. 86. Electrolysis of the Cilia. (Beard)..... 293
Fig. 87. Rochon-Duvigneaud's Transilluminator..... 295
Fig. 88. Leber's Transilluminator..... 296
Fig. 89. Sachs' Transilluminator..... 297
Fig. 90. Lange's Transilluminator..... 298
Fig. 91. Würdemann's Transilluminator..... 299
Fig. 92. Marple's Electric Ophthalmoscope..... 304
Fig. 93. De Zeng's Electric Ophthalmoscope..... 306
Fig. 94. De Zeng's Electric Retinoscope..... 307
Fig. 95. Snell's Electric Spud and Knife-Needle..... 309
Fig. 96. The Sideroscope of Asmus..... 310
Fig. 97. The Magnetometer of Gérard..... 312
Fig. 98. Hirschberg's Sideroscope..... 313
Fig. 99. The Principle of Sweet's Method of Location..... 329
Fig. 100. Indicating Apparatus in Position. (Sweet)..... 330
Fig. 101. Diagram of Position of Foreign Body in Eyeball. (Sweet)..... 331
Fig. 102. Sweet's New Localizer..... 332
Fig. 103. The Patient in Position. (Sweet)..... 333
Fig. 104. Localization Chart, with Lines Representing Course of X-Rays. (Sweet) 334
Fig. 105. Plate Showing Focal Coördinates. (Sweet)..... 335
Fig. 106. Radiograph of Foreign Body in the Eye. (Sweet)..... 336
Fig. 107. Hulen's Method of Localization..... 338
Fig. 108. Dixon's Apparatus for Localization..... 340
Fig. 109. Patient in Position. Dixon's Method..... 341
Fig. 110. Indicator in Position. Dixon's Method..... 342
Fig. 111. Ramsay's Method of Localization..... 345
Fig. 112. Hirschberg's Magnet..... 348
Fig. 113. Haab's Magnet..... 351
Fig. 114. Volkmann's Magnet..... 353
Fig. 115. Mellinger's Magnet, Showing Method of Use..... 355
Fig. 116. Method of Using the Haab Magnet..... 365
Fig. 117. Method of Election in Removing Foreign Bodies from Vitreous with the Magnet..... 367

PART III, CHAPTER V.

ANESTHESIA, LOCAL AND GENERAL, IN OPHTHALMIC OPERATIONS.

Fig. 118. How the Anesthetist May Interfere with the Manipulations of the Surgeon..... 379
Fig. 119. Lefever's Device to Permit Use of a General Anesthetic and at Same Time Afford the Surgeon the Greatest Possible Free Field 380
Fig. 120. Miller's Apparatus to Remove the Anesthetic from Field of Operation 381
Fig. 121. Teter Apparatus for Nitrous Oxide and Oxygen, and Other Combination Anesthetics..... 384
Fig. 122. Gatch's Apparatus for Use of Nitrous Oxide by Rebreathing... 385
Fig. 123. Points of Introduction of Needle Over the Infratrochlear, Lachrymal and Infraorbital Nerves. (Chevrier and Cantonnet) 391
Fig. 124. Technique of Paraneural Infiltration. (Hertzler)..... 392
Fig. 125. Areas of Anesthesia (regional) Produced by the Introduction of Anesthetic Solutions..... 393

Page

Fig. 126. Showing How Far the Hypodermic Needle Should Be Introduced for the Production of Infiltration Anesthesia. (Hertzler) 394
Fig. 127. Proper Technique for the Protection of Infiltration Anesthesia. (Hertzler) 396
Fig. 128. Grossman Company's Office Apparatus for the Preparation of Pencils of "Carbon Dioxide Snow" 401
Fig. 129. Modification of the "Undine," for Sterilization of Anesthetic Solutions 407

PART III, CHAPTER VI.

SOME REMEDIES, APPLIANCES AND PROCEDURES EMPLOYED IN MINOR OPHTHALMIC SURGERY.

Fig. 130. Bottle and Medicine Dropper 411
Fig. 131. Undine 411
Fig. 132. Stroschein's Sterile Solution Holder 414
Fig. 133. Bottle with Irrigating Syringe 414
Fig. 134. Todd's Eye Irrigator 415
Fig. 135. Ellett's Anterior Chamber Irrigator 415
Fig. 136. Ring's Ocular Mask 418
Fig. 137. Ordinary Eye Shield 418
Fig. 138. Fuchs' Wire Mask 419
Fig. 139. Single Roller Bandage 420
Fig. 140. Double Roller Bandage 421
Fig. 141. Eye Pads on Ice for Application of Extreme Cold 426
Fig. 142. Method of Keeping Water Warm 427
Fig. 143. Massaging the Lower Lids 430
Fig. 144. Massage of Lids and Eyeball. (Murray) 430
Fig. 145. Corneal Masseur 432
Fig. 146. Beck-Mueller Paraffin Injector 441
Fig. 147. Broeckaert's Paraffin Injector 442
Fig. 148. Artificial Leech 446
Fig. 149. Kauffmann's Apparatus for Massage of Eyeball 455
Fig. 150. Various Forms of Prothesis After Enucleation and Orbital Exenteration 461
Fig. 151. Artificial Shell Eye 461
Fig. 152. Introducing Artificial Eye 464
Fig. 153. Removing Artificial Eye 464
Fig. 154. Sutures Inserted Into Bridge of Conjunctiva in the Maddox Traction Flap Operation for Astigmatism 467

PART III, CHAPTER VII.

THE INSTRUMENTS USED IN OPHTHALMIC SURGERY.

Fig. 155. Scalpels 473
Fig. 156. Bistouries 474
Fig. 157. Lachrymal Knives 475
Fig. 158. Keratomes 476
Fig. 159. Cystotomes 476
Fig. 160. Knife-Needles 477
Fig. 161. Tattooing and Other Needles Mounted on Straight Handles 478
Fig. 162. Knives Used in Cataract Extraction 480
Fig. 163. Canaliculus and Lachrymal Duct Probes and Dilators 482
Fig. 164. Repositors 483
Fig. 165. Various Ophthalmic Instruments 484
Fig. 166. Loops 485
Fig. 167. Hooks 486
Fig. 168. Spuds 486
Fig. 169. Retractors 487
Fig. 170. Instruments Not Otherwise Classified 488
Fig. 171. Forceps-Scissors 490

Page

Fig. 172. Scissors-Handled Punches ... 491
Fig. 173. Forceps ... 492
Fig. 174. Forceps (Concluded) ... 494
Fig. 175. Scissors-Handled Forceps ... 495
Fig. 176. Chalazion Forceps ... 496
Fig. 177. Scissors ... 497
Fig. 178. Scissors (Concluded) ... 498
Fig. 179. Needle Holders ... 499
Fig. 180. Lid Clamps ... 502
Fig. 181. Lid Specula ... 504
Fig. 182. Syringes ... 505
Fig. 183. Cautery Appliances ... 506
Fig. 184. Irrigators ... 507
Fig. 185. Irrigators (Concluded) ... 508
Fig. 186. Instruments Not Otherwise Classified ... 509
Fig. 187. Unclassified Instruments (Concluded) ... 510

PART III, CHAPTER VIII.

OPHTHALMIC HOSPITALS, HOSPITAL WARDS AND ROOMS; THEIR FURNITURE AND EQUIPMENT.

Fig. 188. Bedside Table ... 515
Fig. 189. Haile's Illuminator Attachment for the Ophthalmoscope ... 516
Fig. 190. Portable Corneal Microscope for Hospital Practice ... 517
Fig. 191. Adjustable Reflector on Stand for Operations and Examinations 518
Fig. 192. Convenient Electric Fixture for Indirect Lighting of Rooms ... 519
Fig. 193. Multiple Electric Lamp Fixture for Indirect (Ceiling) Illumination ... 519
Fig. 194. Electric Hand Lamp with Shade for Use in Wards or Private Rooms for Operations, Examinations and Dressings ... 520
Fig. 195. Ophthalmoscope Lamp for Ward Practice. (Gradon) ... 521
Fig. 196. Electric Ophthalmoscope for Use in Hospital Practice. (Marple) 522
Fig. 197. Priestley Smith's Lamp for Ward Use ... 522
Fig. 198. Abney Pellet Ward Test for Color Blindness. (Oliver) ... 523
Fig. 199. Hood Lamp for Use in the Operating Room ... 524
Fig. 200. Instrument Cabinet for Ophthalmic Operating Room ... 525
Fig. 201. Knife Sterilizer. (Grosse) ... 526
Fig. 202. Ophthalmic Knife Sterilizer. (Grosse) ... 527
Fig. 203. Detachable Stretcher for Conveying Patients to Wards or to Their Rooms from Operating Theatre ... 528
Fig. 204. Aseptic Hospital Bed ... 530
Fig. 205. Observation Stand for Witnessing Ophthalmic Operations ... 531
Fig. 206. Portable Sterilizer for Eye Instruments. (Veasey) ... 532
Fig. 207. Strocheim Apparatus for Sterilizing Ophthalmic Solutions ... 533
Fig. 208. Anterior Chamber Irrigator for Ophthalmic Operating Room. (Lippincott) ... 534
Fig. 209. Eye Operating Room, Manhattan Eye, Ear and Throat Hospital 535
Fig. 210. The Webster Fox Operating Table ... 538

PART IV, CHAPTER I.

OPERATIONS FOR ENUCLEATION OF THE EYE AND THEIR SUBSTITUTES.

Fig. 211. The Extirpation Method of Bartisch ... 551
Fig. 212. Spoons and Knife of Bartisch for Enucleation of Eyeball ... 552
Fig. 213. Another Knife Used by Bartisch in Extirpation of the Globe ... 553
Fig. 214. The Ferrall or Bonnet Enucleation. Speculum Inserted and Circumcorneal Incision Being Made ... 556
Fig. 215. The Ferrall Enucleation Operation. Circumcorneal Incision Completed ... 557
Fig. 216. Ferrall Enucleation. Cutting of the Tendons ... 558

Page

Fig. 217. The De Weltz Enucleation Spoon 559
Fig. 218. The Joseph Hook-Neurotome 560
Fig. 219. Suturing of a Collapsing Globe during Enucleation 561
Fig. 220. Enucleation of Eyeball. Würdemann's Purse-String Suture 563
Fig. 221. Enucleation of Eyeball. (Allport) 564
Fig. 222. Enucleation of Eyeball (Allport). Continued 565
Fig. 223. Enucleation of Eyeball (Allport). Continued 566
Fig. 224. Enucleation of Eyeball (Allport). Continued 567
Fig. 225. Enucleation of Eyeball (Allport). Concluded 568
Fig. 226. Enucleation of Eyeball. de Wecker's Purse-String Suture, Inserted Before Tendons Are Cut 569
Fig. 227. Enucleation of Globe. (Simeon Snell) 570
Fig. 228. Enucleation of Eyeball (Simeon Snell). Continued 571
Fig. 229. Enucleation of Eyeball (Simeon Snell). Concluded 572
Fig. 230. Enucleation of Eyeball. (Ernest Clarke) 573
Fig. 231. Enucleation of Eyeball. (Ernest Clarke) 573
Fig. 232. Enucleation of Eyeball. (Priestley Smith) 574
Fig. 233. Enucleation of Eyeball. The Vienna Method 575
Fig. 234. Enucleation of the Eyeball. The Vienna Method. (Continued) 576
Fig. 235. Enucleation of the Eyeball. The Vienna Method. (Concluded) 577
Fig. 236. Abscission. Critchett's Method 578
Fig. 237. Abscission. Method of Lagrange 579
Fig. 238. Abscission. Method of Lagrange. (Continued) 580
Fig. 239. Abscission. Method of Lagrange. (Continued) 580
Fig. 240. Abscission. Method of Lagrange. (Continued) 581
Fig. 241. Abscission. Method of Lagrange. (Continued) 585
Fig. 242. Abscission. Method of Lagrange. (Concluded) 585
Fig. 243. Abscission. Beer's Knife in Position 586
Fig. 244. Abscission. Removing Lower Flap with Scissors 587
Fig. 245. Evisceration Scoop Used in Evisceration or Mules' Operation .. 588
Fig. 246. Abscission or Evisceration. Closure of Wound 589
Fig. 247. Incision for Removal of a Staphyloma 590
Fig. 248. Mules' Operation. Removal of Triangular Pieces of Sclera to Facilitate Accurate Closure of the Opening 591
Fig. 249. Mules' Operation. Bissell's Method of Preparation of the Opening 592
Fig. 250. Mules' Operation. Showing Different Sizes of Balls 594
Fig. 251. Mules' Operation. Instrument for Insertion of Ball 595
Fig. 252. Mules' Operation. Instrument for Insertion of Ball 596
Fig. 253. Mules' Operation. Showing Ball in Place and Scleral Sutures in Position 597
Fig. 254. Mules' Operation. Scleral and Conjunctival Sutures in Position 598
Fig. 255. Mules' Operation. Closure of Wound 599
Fig. 256. Mules' Operation. The Fox Conformer 600
Fig. 257. Ramsay's Parafin Syringe 605
Fig. 258. Implantation of Ball (Oliver). Four Suture Recti Muscles .. 612
Fig. 259. Implantation of Ball (Oliver). Suturing Conjunctival Opening 613
Fig. 260. Implantation of Ball (Oliver). Ball and Artificial Shell in Position 614
Fig. 261. Delayed Implantation (Fox). Opening in the Sockets 615
Fig. 262. Delayed Implantation (Fox). Ball in Position and the Opening Sutured 616
Fig. 263. Delayed Implantation (Lagrange). Opening the Socket and the Tissues Being Undermined 617
Fig. 264. Delayed Implantation (Lagrange). Hollow Shell in Position and Tissues Sutured Over It 618
Fig. 265. Delayed Implantation (Lagrange). The Hollow Shells 619
Fig. 266. Delayed Implantation (Lagrange). Completed Operation and Artificial Eye in Position 619
Fig. 267. Optico-Ciliary Neurotomy. Showing Conjunctival Incision and Muscle Tied, Latter being Held on a Strabismus Hook 622
Fig. 268. Optico-Ciliary Neurotomy. Severing the Muscle 623
Fig. 269. Optico-Ciliary Neurotomy. Cutting the Optic Nerve 624

Page

Fig. 270. Optico-Ciliary Neurotomy. Cutting the Ciliary and Optic Nerves 625
Fig. 271. Optico-Ciliary Neurotomy. The Sutured Muscle..... 626
Fig. 272. Optico-Ciliary Neurotomy. The Sutured Conjunctiva..... 627
Fig. 273. Scissors of Vollert..... 628
Fig. 274. Scissors of Vollert..... 629
Fig. 275. Preparatory Evisceration for Huizinga's Operation..... 630
Fig. 276. Operation of Huizinga. Grasping the Sclera from the Inside of the Eye 631
Fig. 277. Operation of Huizinga. Cutting Away a Portion of the Sclera from the Inside of Eye..... 632
Fig. 278. Socket after Implantation of Rabbit's Eye..... 634
Fig. 279. Profile View of Ordinary Artificial Eye..... 640
Fig. 280. Profile View of Snellen Eye..... 640
Fig. 281. Profile View of Snellen Eye..... 640
Fig. 282. Artificial Eye with Gold Spring..... 641
Fig. 283. Snellen's Improved Eye..... 641

PART IV, CHAPTER III.

OPERATIONS ON THE EXTRINSIC OR ORBITAL MUSCLES.

Fig. 284. Muscles of Orbit as Viewed from Above and Behind..... 651
Fig. 285. Diagram Showing Influence of Internal Rectus Muscle on Vertical Movements..... 652
Fig. 286. Action of Internal Rectus Muscle, When the Eye Is Turned Down Helping to Turn it Down..... 653
Fig. 287. Angle which the Direction of Central Fibres of Superior Rectus or Inferior Rectus make with the Median Plane of Head or with the Direction of Visual Axis when the Eyes are in Primary Position..... 654
Fig. 288. Eye Turned 26 Degrees Toward the Temporal Side..... 655
Fig. 289. Eye Turned More than 26 Degrees Toward the Temporal Side 655
Fig. 290. Eye Turned Strongly in. Superior and Inferior Recti Muscles Act as Adductors..... 656
Fig. 291. Actions of the Different Extrinsic Ocular Muscles when the Eye is Turned Strongly Outward..... 656
Fig. 292. Contact Arcs of External and Internal Recti Muscles when the Eye is Turned Outward..... 657
Fig. 293. Contact Arcs of External and Internal Recti when Eye is Turned in 658
Fig. 294. Loss of Contact Arc from Tenotomy..... 659
Fig. 295. Practical Loss of Contact Arc by Adhesion of Tendon to Sclera Back from the Normal Insertion..... 660
Fig. 296. Relations of Extrinsic Ocular Muscles to Connective Tissue Structures of Orbit as Viewed from Above and Behind. (After Motais) 661
Fig. 297. Condensations of Orbital Connective Tissue..... 662
Fig. 298. Tension and Relaxation of Lateral Check Ligaments, when Eyes are Turned Strongly to the Right..... 663
Fig. 299. Influence of Tenotomy and Advancement on the Check Ligaments 664
Fig. 300. Double Curved Barded Strabismus Hooks. (Bolton)..... 671
Fig. 301. Instruments Generally Used in Muscle Operations..... 677
Fig. 302. Instruments Generally Used in Muscle Operations (Concluded) 678
Fig. 303. Tenotomy by the Open Method 680
Fig. 304. Tenotomy by the Subconjunctival Method of Snellen..... 688
Fig. 305. Tenotomy of Internal Rectus and Superior Rectus at One Operation 692
Fig. 306. Extended Tenotomy of Internus. Relations of Conjunctival Incision to Cornea and the Insertion of the Tendons..... 694
Fig. 307. Effect of Partial Tenotomy where Central Portion of the Insertion is Divided 698

Page

Fig. 308. Partial Tenotomy where One Side of Tendon is Freed from the Insertion and Retracted 699
Fig. 309. Partial Plastic Tenotomy of Verhoeff 700
Fig. 310. Partial Tenotomy by Lateral Incisions (Todd) 701
Fig. 311. Stephenson's Method of Lengthening the Tendon by Step-like or Oblique Incision and Suturing 702
Fig. 312. Modifications of Tendon Lengthening Suggested by Landolt .. 703
Fig. 313. Grimsdale's Tongue-like Incision for Tendon Lengthening 704
Fig. 314. Stephenson's Method of Lengthening a Tendon by Dividing and Introducing a Silk Suture Between the Cut Ends 704
Fig. 315. Method of Exposing Tendon of Superior Oblique 705
Fig. 316. Critchett's Method of Advancement 705
Fig. 317. Advancement with Single Scleral Stitch 708
Fig. 318. Advancement with Scleral Stitch in Center, and Superficial Stitches Above and Below, at Completion of Operation 708
Fig. 319. Advancement with Partial Isolation of Tendon. Method of Landolt 710
Fig. 320. Advancement with Pulley Stitch. (Prince) 711
Fig. 321. Pulley Advancement (Prince) with Tissue Excised 712
Fig. 322. Single Stitch Advancement of Williams 713
Fig. 323. Single Stitch Advancement. (Beard) 713
Fig. 324. Advancement with Splitting of Tendon. (Valude) 715
Fig. 325. Advancement with Suture Carried Around the Cornea. (Argyll-Robertson) 715
Fig. 326. Advancement with Two Sutures. (Black) 716
Fig. 327. Advancement by Wootton's Method 717
Fig. 328. Advancement Sutures as Placed by Worth 718
Fig. 329. Advancement Stitch by Stevenson 719
Fig. 330. Advancement Stitch by Verhoeff Showing Different Stages 720
Fig. 331. Advancement Stitch of Lea 721
Fig. 332. Advancement Stitch of Cogan 721
Fig. 333. Advancement by the Method of deWecker, Showing Introduction of Sutures 723
Fig. 334. Folding of Tendon as Done by Lagleyze 723
Fig. 335. Stitch for Folding Tendon, Proposed by Suffa 725
Fig. 336. Advancement by Folding After Partial Tenotomy and Splitting of the Tendon (Colburn) 725
Fig. 337. Folding Forward of the Split Tendon (Magnani) 726
Fig. 338. Clark's Double Hook for Advancement by Folding the Tendon 728
Fig. 339. Green's Instrument and Operation for Folding the Tendon 729
Fig. 340. Todd's Operation for Tendon Tucking 730
Fig. 341. Levinsohn's Instrument for Seizing and Folding the Tendon 731
Fig. 342. Brigg's Instrument for Tendon Shortening by Use of Silver Wire Clamp 732
Fig. 343. Advancement with Resection of the Tendon as Done by J. F. Noyes 733
Fig. 344. Advancement with Resection as Done by Reese 734
Fig. 345. Transplantation of Superior Rectus for Paralysis of Superior Oblique 739
Fig. 346. Change of Insertion of Tendon for the Operative Treatment of Declinations (Stevens) 740
Fig. 347. Method of Excision of Capsule and Conjunctiva for Divergent Strabismus (Fox) 744
Fig. 348. Advancement with Excision (Fox) 745

PART IV, CHAPTER IV.

SURGICAL TREATMENT OF INJURIES TO THE VISUAL APPARATUS.

Fig. 349. Elwood Wash Bottle 758
Fig. 350. Todd Wash Bottle 758
Fig. 351. Undine 759

Page

Fig. 352. Taylor's Method of Tying the Canaliculus in Dacryocystitis before Operation Involving Opening of the Eyeball, as Adopted by the Author 760
Fig. 353. Fuchs' Wire Mask 763
Fig. 354. Emerson's Double Wire Mask 764
Fig. 355. Ring's Papier-Maché Mask 764
Fig. 356. MacWhinnie's Artificial Leech 765
Fig. 357. How to Expose Fully the Retrotarsal Folds 767
Fig. 358. Kuhnt's Single Pedunculated Flap 769
Fig. 359. Kuhnt's Bipedunculated Flap 770
Fig. 360. Kuhnt's Double Flaps 771
Fig. 361. Abscission of Cystoid Cicatrix 772
Fig. 362. Conjunctival Flap Over Scleral Wound 773
Fig. 363. deWecker's Temporary Conjunctival Covering of Cornea 773
Fig. 364. deWecker's Temporary Conjunctival Covering, Sutures Tied .. 774
Fig. 365. Author's Pouch Conjunctival Suture 774
Fig. 366. Kuhnt's Bipedunculated Flap for Cataract Extraction 775
Fig. 367. Conjunctival Flap for Cataract Extraction 775
Fig. 368. Lattice Suture of Conjunctival Flap Over Extensive Penetrating Wound of Cornea and Sclera. (Maddox) 775
Fig. 369. Modified Kuhnt Keratoplasty (Koyle) 776
Fig. 370. Corneal Suture 777
Fig. 371. Todd's Corneal Cautery 778
Fig. 372. Knapp's Galvano-Cautery Electrodes 778
Fig. 373. Keratotomy or Saemisch Section, in Hypopion Ulcer 779
Fig. 374. Introduction of a Pencil of Iodoform into the Anterior Chamber in a Case of Infection by a Foreign Body 780
Fig. 375. Lippincott Irrigator for Anterior Chamber 781
Fig. 376. Würdemann's Lamp and Transilluminator 782
Fig. 377. Snell's Electric Lighted Spud 782
Fig. 378. Berger's Binocular Loup 783
Fig. 379. Todd's Foreign Body Instrument 784
Fig. 380. Author's Mattress Suture 789
Fig. 381. Nuel's Suture for Scleral Rupture 790
Fig. 382. The William Fisher Lid Elevator 791
Fig. 383. Smith's Hook for Elevation of Lid 792
Fig. 384. Wilder's Dilator 792
Fig. 385. Collins' One-Half Curved Iris Forceps 792
Fig. 386. Method of Sliding Flap and Wolfe Graft Transplantation for Restoration of the Lower Lid 804
Fig. 387. Autoplasty After the Italian Method (Berger) 805
Fig. 388. Results of Operation for Restoration of Orbit. Author's Case 806
Fig. 389. Severe Burn of Face and Scalp, with Loss of Left Eye, Treated by Thiersch Skin Grafting. Author's Case 807

PART V, CHAPTER I.

SOME OPERATIONS ON THE ORBITAL WALLS AND CONTENTS.

Fig. 390. Horizontal Section of Orbit 815
Fig. 391. Coronal Section Through Right Eye and Orbit 816
Fig. 392. Relations of the Anterior Ocular Apparatus and Eyeball to the Orbit. (After Merkel) 817
Fig. 393. Golovine's Operation for Securing an Artificial Eye and Exenteration of the Orbit. Primary Incisions 831
Fig. 394. Golovine's Operation for Securing an Artificial Eye after Orbital Exenteration. Suturing Skin Flaps in Position 832
Fig. 395. Exenteratio Orbito-sinualis. Incision of the Soft Parts. (Golovine) 835
Fig. 396. Exenteratio Orbito-sinualis. Line of Removal of Bony Parts. (Golovine) 836
Fig. 397. Exenteratio Orbito-sinualis. Union of Skin Flaps Over the Exenterated Cavity. (Golovine) 837
Fig. 398. Exenteratio Orbito-Sinualis. Cosmetic Result (Golovine) 838

Page

Fig. 399. Krönlein Operation. Incision Through the Soft Parts..... 852
Fig. 400. Krönlein Operation. Incisions Through the Bones..... 854
Fig. 401. Czermak's Osteoplastic Resection of the External Orbital Wall 856
Fig. 402. Cysticercus Cellulosa Iridis..... 859

PART VI, CHAPTER I.

THE OPERATIVE TREATMENT OF PTERYGIUM

Fig. 403. Young's Knife 868
Fig. 404. Agnew's Modified Iridectomy Knife..... 868
Fig. 405. Pterygium Suitable for the Drake-Brockman Operation..... 869
Fig. 406. Drake-Brockman Operation for Pterygium. Exsection of Diamond-shaped Area 869
Fig. 407. Final Stages of Drake-Brockman Operation for Pterygium.... 869
Fig. 408. Arlt's Operation for Pterygium, Showing Lines of Incisions.. 871
Fig. 409. Arlt's Operation for Pterygium, Scleral Defect After Removal of "*accommodation incisions*," and Introduction of Sutures. 872
Fig. 410. Arlt's Operation for Pterygium Completed..... 872
Fig. 411. Hobby's Operation for Pterygium, Showing Lines of Incision 873
Fig. 412. Hobby's Operation Completed..... 873
Fig. 413. Lipscomb's Excision Operation for Pterygium, Showing Plan of Removal of Conjunctival Defect..... 874
Fig. 414. Lipscomb's Operation of Pterygium, Completed..... 874
Fig. 415. Desmarres' Transplantation Operation for Pterygium..... 875
Fig. 416. Desmarres' Operation, Showing Pterygium Transplanted into Lower Front 875
Fig. 417. Knapp's Operation for Pterygium..... 876
Fig. 418. Knapp's Operation for Pterygium (Continued)..... 876
Fig. 419. Knapp's Operation for Pterygium (Continued)..... 876
Fig. 420. Knapp's Operation, Completed..... 876
Fig. 421. McReynold's Operation for Pterygium 877
Fig. 422. McReynold's Operation, Completed..... 877
Fig. 423. Fox's Simple Transplantation of Pterygium with Conjunctival Sutures 878
Fig. 424. Fox's Simple Transplantation of Pterygium with Conjunctival Sutures, Completed 878

PART VI, CHAPTER II.

OPERATIONS AND OTHER SURGICAL TREATMENT FOR THE RELIEF AND CURE OF TRACHOMA.

Fig. 425. Trachoma Follicles in Adenoid Tissue of the Transition Fold 883
Fig. 426. Operation of Rolling or Expression..... 888
Fig. 427. Claiborne's Roller Forceps 890
Fig. 428. Jameson's Trachomatome 894
Fig. 429. Massage of the Trachomatous Conjunctiva..... 897
Fig. 430. Darier's Forceps for Grasping the Lid..... 899
Fig. 431. Use of Darier's Forceps..... 900
Fig. 432. Hook for Holding Eyelid when Everted (Lindsay Johnson).. 901
Fig. 433. Horn or Celluloid Spatula, Laid on Upper (or Lower) Rim of Orbit, Everted Lid Over it and Held by Double Hook (Lindsay Johnson) 902
Fig. 434. Spatula Curved so as to Rest Against Upper Surface of Lid... 903
Fig. 435. Three-bladed Knife for Making Incisions Across the Lid..... 904
Fig. 436. Blades Spread Apart to Clean..... 904
Fig. 437. Sillonneur, or Plough, which takes the 20 or 25 Milliampere current 904
Fig. 438. Handle to Hold Blades When Sharpened 905
Fig. 439. Metal Head Fixed to Battery Wires to Decompose Corners which the Plough cannot Easily Reach..... 906
Fig. 440. Excision of Tarsus. First Act. (Kuhnt)..... 910
Fig. 441. Excision of Tarsus. Second Act. (Kuhnt)..... 911

Page
Fig. 442. Excision of the Tarsus. Third Act. (Kuhnt) 912
Fig. 443. Excision of the Tarsus. Fourth Act. (Kuhnt) 913
Fig. 444. Modifications of Combined Excision (Beard) 915
Fig. 445. Peridectomy 919
Fig. 446. Peritomy 920

PART VI, CHAPTER III.

THE SURGICAL TREATMENT OF CORNEAL ULCER AND FISTULA.

Fig. 447. Eyelids Naturally Open, Horizontal Plane Passes Through the Inner Canthus 925
Fig. 448. Normal Cornea, Magnified Thirty-six Times. (Verhoeff) 926
Fig. 449. Ophthalmic Curettes of Various Shapes and Sizes 928
Fig. 450. Cautery Points 933
Fig. 451. Wadsworth Cautery 934
Fig. 452. Thermo-Cautery (Paquelin) Points 935
Fig. 453. Plain Interrupting Handle for Electrodes 936
Fig. 454. Rodent Ulcer of the Cornea (Randolph) 937

PART VI, CHAPTER IV.

PARACENTESIS, KERATOTOMY, CONJUNCTIVOPLASTY AND SOME OTHER OPERATIONS ON THE CORNEA.

Fig. 455. Combined Needle and Spud for Removal of Foreign Bodies from Cornea 944
Fig. 456. Toothed Forceps of von Graefe 945
Fig. 457. Nodular Opacity of Cornea, One Year Before Operation 947
Fig. 458. Nodular Opacity of Cornea, One Year After Operation 947
Fig. 459. Paracentesis of Cornea (Stellwag) 954
Fig. 460. Todd's Cautery Instrument 955
Fig. 461. Wolfe's Method of Removal of Hypopyon 959
Fig. 462. Dilation and Contraction of Artificial Pupil in Conical Cornea 966
Fig. 463. Meyer's Needle for the Operation of Conical Cornea 967
Fig. 464. Galvano-Cautery Burner for Conical Cornea 970
Fig. 465. Implantation of Pins in a Staphyloma (Borelli) 974
Fig. 466. Application of Ligature to a Staphyloma (Borelli) 974
Fig. 467. Splitting of a Staphyloma (Stellwag) 977
Fig. 468. Position of Needle Punctures in Knapp's Operation for Total Staphyloma 980
Fig. 469. Position of Stitches in Knapp's Operation for Total Staphyloma 981
Fig. 470. Position of Stitches in de Wecker's Operation for Total Staphyloma. First Stage 982
Fig. 471. Position of Stitches in de Wecker's Operation for Total Staphyloma. Final Stage 983
Fig. 472. Partial Separation of Staphyloma from its Base (Stellwag) 984
Fig. 473. Implantation of Needle and Excision in Critchett's Operation for Total Cicatricial Staphyloma 985
Fig. 474. Arrangement and Position of Interrupted Sutures in Critchett's Operation for Total Cicatricial Staphyloma 986
Fig. 475. Kuhnt's Method of Making Tongue-like Conjunctival Flap .. 993
Fig. 476. Kuhnt's Method of Making Centrally Placed Conjunctival Flap 994
Fig. 477. Kuhnt's Third Method of Making Conjunctival Flap to Cover Corneal Wound 995
Fig. 478. Arrangement of Sutures in Conjunctival Flap 996
Fig. 479. Shape and Position of Conjunctival Flap in Front of Coloboma 997
Fig. 480. Conjunctival Flap Over Corneoscleral Break 998
Fig. 481. Coloration Massings in Old Pigmented Cornea 1000
Fig. 482. Capsule Bacillus Found in Chinese Ink 1001
Fig. 483. Tyson's Tattooing Needle 1002
Fig. 484. Corneal Trephine of Holth 1004
Fig. 485. Double Tattooing Trephine of Barck 1005

PART VI, CHAPTER V.

OPERATIONS FOR CONICAL CORNEA.—KERATOPLASTY.

Page

Fig. 486. Conical Cornea 1007
Fig. 487. Critchett's Operation for Conical Cornea 1010
Fig. 488. Cauterization of Apex of Cone 1011
Fig. 489. Knapp's Cautery Points for Conical Cornea 1012
Fig. 490. von Hippel's Trephine 1022
Fig. 491. von Hippel's Trephine 1023

PART VI, CHAPTER VI.

IRIDECTOMY, IRIDOTOMY AND SOME ALLIED OPERATIONS.

Fig. 492. Landolt's Blepharostat 1026
Fig. 493. Fixation Forceps 1026
Fig. 494. von Graefe Knife and How to Hold it 1027
Fig. 495. Lance-shaped Knives and How to Hold them 1028
Fig. 496. Iris Forceps 1029
Fig. 497. Iris Scissors 1030
Fig. 498. Spatula 1031
Fig. 499. Incision with the Straight Lance Knife. (After Valude) 1032
Fig. 500. Incision with the Bent Lance Knife. (After Beard) 1033
Fig. 501. Incision with the Graefe Knife. (After Valude) 1034
Fig. 502. Blunt-pointed Lance Knife 1035
Fig. 503. Mathieu Forceps 1035
Fig. 504. Introduction of the Iris Forceps 1036
Fig. 505. Opening the Iris Forceps 1036
Fig. 506. Grasping the Iris 1036
Fig. 507. Drawing out the Iris Through the Corneal Incision (After Valude) 1036
Fig. 508. Cutting off the Iris with *pince-ciseaux* (After Beard) 1037
Fig. 509. Beer's Iridotomy with Broad Iris Knife (After Mackenzie) 1046
Fig. 510. Straight and Angular Stop-keratomes 1047
Fig. 511. Simple Iridotomy 1048
Fig. 512. Double Iridotomy, deWecker's Method (After Valude) 1049
Fig. 513. Various Knife-needles and Iris Knives for Iridotomy (After Ziegler) 1050
Figs. 514 and 515. Ziegler's V-shaped Iridotomy Knife-needle Entered Through the Cornea 1051
Figs. 516 and 517. Jobson's Iridotome and Iridotomy 1052
Fig. 518. deWecker's Iridoëctomy with a Lance Knife (After Valude) 1053
Fig. 519. deWecker's Iridoëctomy with a von Graefe knife (After Valude) 1054
Fig. 520. Abadie's Iridoëctomy (After Beard) 1055
Fig. 521. Arlt's Iris-Punch 1056
Fig. 522. Critchett's Iridenkleisis. (After Valude) 1057
Fig. 523. Bowman's Double Iridenkleisis for Keratoconus. (After Valude) 1058
Fig. 524. Jameson's Reattachment in Iridodialysis 1059
Fig. 525. Abadie's Staphylotomy 1062
Fig. 526. Schulek's Sphincterolysis Anterior 1062

PART VI, CHAPTER VII.

THE OPERATIVE TREATMENT OF GLAUCOMA.

Fig. 527. Blood Vessels of Eyeball 1065
Fig. 528. Angle of Anterior Chamber in a Healthy Eye. (After Collins) 1070
Fig. 529. Angle of Anterior Chamber in a Case of Primary Glaucoma. (After Collins) 1071
Fig. 530. Glaucoma Secondary to Iritis and the Formation of Annular Posterior Synechia. (After Collins) 1072

Page

Fig. 531. Section through Center of Coloboma in an Eye which had had an Iridectomy Performed for Glaucoma of Two Months' Standing 1073
Fig. 532. Glaucoma Secondary to Traumatic Dislocation of the Lens. (After Collins) 1074
Fig. 533. Angle of Anterior Chamber in an Eye which had Glaucoma Secondary to Serous Iridocyclitis. (After Collins)....1075
Fig. 534. Angle of Anterior Chamber in a Case of Congenital Glaucoma or Primary Buphthalmos. (After Collins)....1077
Fig. 535. Anterior Sclerotomy 1080
Fig. 536. Instruments for Iridectomy 1088
Fig. 537. Iridectomy for Glaucoma....1089
Fig. 538. Method of Holding the Bent Keratome for Incision of the upper Corneal Margin. (Czermak)....1090
Fig. 539. Making the Sclero-iridectomy. (After Beard)....1091
Fig. 540. Iridectomy in Glaucoma. (Fuchs)....1092
Fig. 541. Diagram Showing Point of Knife Thrust Just Through at the Limbus 1092
Fig. 542. Method of Holding the Straight Graefe for Upward Incision. (Czermak) 1093
Fig. 543. Diagram Showing Point of Knife Directed Toward a Point in the Cornea about 1mm. Within the Limbus....1094
Fig. 544. Blades of Iris Forceps Held Close to the Pupillary Margin have just been Opened....1095
Fig. 545. Blades have been Closed and have Seized a Fold of the Iris..1095
Fig. 546. Portion of Iris, which has been Drawn Forward, is Cut Off by Scissors Brought from Below....1095
Figs. 547, 548 and 549. Illustrating Different Steps in the Lagrange operation 1110
Fig. 550. The Wedge Isolation Operation....1114
Fig. 551. Two Lines Representing Conjunctival Incisions nearly Completing a Conjunctival Flap....1115
Fig. 552. Vacher's Punch-forceps Modified by Holth for Sclerectomy....1116
Fig. 553. Holth's Elbowed Fixation Forceps....1116
Fig. 554. Holth's Double Blunt Hook for Turning Back the Conjunctiva after Subconjunctival Incision with a Keratome....1117
Fig. 555. Diagram of Sclerectomy (by Holth's method) of the Anterior Lip with a Punch-forceps after Incision with a Narrow von Graefe Knife 1117
Fig. 556. Elliot's Operation. First Stage....1118
Fig. 557. Elliot's Operation. Second Stage....1119
Fig. 558. The Sclerostome, Ready for Use....1120
Fig. 559. Position of Incision, Sclerostome in Position and Fistula Completed 1120
Fig. 560. Cyclodialysis in the Left Eye. (After Meller)....1124
Fig. 561. Cyclodialysis. (After Meller)....1125
Fig. 562. Cyclodialysis. (After Meller)....1126

PART VI, CHAPTER VIII.

EXTRACTION OF THE SENILE TYPE OF CATARACT.

Fig. 563. Section of Eyeball to Show Crystalline Lens and its Bulbar Relations. (After Quain)....1137
Fig. 564. The Immediate Relations of the Crystalline Lens System. (After Quain)....1139
Fig. 565. First Knives Used in Cataract Extraction. (Hubbell)....1145
Fig. 566. Thos. Young's Cataract Knife....1146
Fig. 567. Models of Cataract Knives Prior to 1822. (After Lachmann).1147
Fig. 568. Models of Cataract Knives Prior to 1822. (After Lachmann).1148
Fig. 569. Diagram Showing Lines of Incision in the Principle Types of Cataract Extraction to Our Own Times....1150
Fig. 570. Diagram Showing Some of the Lines of Incision in Senile Cataract 1151

Page

Fig. 571. Diagrams of deWecker (1872) and Panas (1876) Corneal Sections in Senile Cataract 1152
Fig. 572. Diagrams Showing Lines of Incision (Concluded)....1153
Fig. 573. Diagram Showing Incision of Steffans....1153
Fig. 574. Modern Sections; Showing Small Conjunctival Flap....1153
Fig. 575. Weber's Cataract Knife....1154
Fig. 576. Henry Howard's Arrow-shaped Knife for Cataract Extraction....1155
Fig. 577. Senile Cataract Extraction....1166
Fig. 578. Senile Cataract Extraction (Continued)....1167
Fig. 579. Senile Cataract Extraction (Continued)....1167
Fig. 580. Senile Cataract Extraction (Continued)....1168
Fig. 581. Senile Cataract Extraction of the Right Eye....1170
Fig. 582. Senile Cataract Extraction of the Right Eye (Continued)....1171
Fig. 583. Extraction of the Senile Cataract, Left Eye (Concluded)....1172
Fig. 584. Diagram Showing Relative Position of the Corneal Section and the (small) Conjunctival Flap....1173
Fig. 585. Simple Anterior Chamber Irrigator for Use in Extraction of Immature Cataract 1178
Fig. 586. Anterior Chamber Irrigator for Use in Extraction of Immature Cataract 1178
Fig. 587. Fuchs' Wire Cataract Shield....1182
Fig. 588. Würdemann Base-ball Cataract Shield....1183
Fig. 589. Concave Shield for Protecting the Eye After Cataract Extraction 1184
Fig. 590. The Clark Speculum 1186
Fig. 591. Angelucci's Superior Rectus Fixation of the Eyeball....1187
Fig. 592. Jackson's Cataract Knife....1188
Fig. 593. Jackson's Cataract Knife; Showing form of Section....1188
Fig. 594. Cystotomes Used by Various Surgeons....1190
Fig. 595. Cystotomes Used by Various Surgeons (Concluded)....1191
Fig. 596. Panas Syringe for Irrigation of the Anterior Chamber in Cataract Extraction 1192
Fig. 597. Anterior Chamber Irrigator made from Bowman's Suction Syringe 1192
Fig. 598. L. Müller's Corneal Incision....1195
Fig. 599. Schulek's Corneal Incision....1195
Fig. 600. Claiborne's Lance-shaped Cataract Knife....1196
Fig. 601. Extraction of Senile Cataract. Some Iridectomies and Iridotomies made in Various "Combined" Methods....1200
Fig. 602. Verhoeff's Modified Iridotomy as Compared with the Usual Iridectomy 1201
Fig. 603. Forms of Capsulotomy. (After Beard)....1204
Fig. 604. Barck's Fan-shaped Capsulotomy....1207
Fig. 605. Steps of Erwin's Capsulotomy....1211
Fig. 606. Fisher's Capsule Forceps....1213
Fig. 607. Tooke's Capsule Forceps....1214
Fig. 608. Intraocular Irrigator of Lagrange and Aubaret....1217
Fig. 609. Greenwood's Intraocular Irrigator....1218
Fig. 610. Maddox's Conjunctival Suture in Cataract Extraction....1219
Fig. 611. Extraction of Senile Cataract. Employment of the Corneal Suture. (Kalt)....1220
Fig. 612. Diagram of Corneal Suture of H. W. Williams....1221
Fig. 613. Diagram of Corneal Suture of de Mendoza....1221
Fig. 614. Diagram of Corneal Suture of Kalt....1222
Fig. 615. Diagram of Corneal Suture of C. H. Williams....1222
Figs. 616-620. Various Steps of the Czermak Sub-conjunctival Operation. (After Czermak)....1223
Fig. 621. Dimmer's Sub-Conjunctival Method of Senile Cataract Extraction 1224
Fig. 622. Forceps Spoon and Toothed Forceps for Use in Crainiciann's Retrociliary Cataract Extraction 1225
Fig. 623. Jameson's Method of Replacing the Iris that has Fallen in Front of the Knife....1228

PART VI, CHAPTER IX.

THE INTRACAPSULAR EXTRACTION OF CATARACT.

Page

Fig. 624. Wright's Method of Cataract Extraction in the Unruptured Capsule 1255
Fig. 625. Instruments Used in Intracapsular Extraction....1257
Fig. 626. Intracapsular Extraction. Smith's Original Instruments About Twenty Years Old....1263
Fig. 627. Modified Graefe Knife, with Straight Cutting Edge....1264
Fig. 628. Instruments Employed by Smith in His Operation for Intracapsular Extraction 1265
Fig. 629. Smith's Toilette 1266
Fig. 630. Cataract Extraction in the Unruptured Capsule. Smith Section 1267
Fig. 631. Clark's Speculum 1269
Fig. 632. Large and Small Extraction Hooks.... 1269
Fig. 633. Double Spatula for Intracapsular Extraction....1270
Fig. 634. Fisher's Capsule Forceps....1270
Fig. 635. Iris Repositor for the Intracapsular Operation....1270
Fig. 636. Greene's Modification of Knapp's Iris Repositor....1271
Fig. 637. Cataract Knife 1271
Fig. 638. Instruments Employed in Author's Intracapsular Extraction..1272
Fig. 639. Scissors for the Intracapsular Operation....1273
Fig. 640. Smith Method with Fisher Lid Elevator. Corneal Incision. (Greene) 1274
Fig. 641. Jullundur Corneal Section....1275
Fig. 642. Intracapsular Extraction. The Iridectomy. (Greene)....1276
Fig. 643. Smith Method. Straight Delivery of the Lens....1277
Fig. 644. Smith Method. "Tumbler" Delivery of the Lens....1278
Fig. 645. Modification of Corneal Incision and Toilette (Greene)....1279
Fig. 646. Straight Delivery of Lens in its Capsule....1282
Fig. 647. Straight Delivery of Lens in its Capsule (Continued)....1282
Fig. 648. Straight Delivery of Lens in its Capsule (Continued)....1283
Fig. 649. Straight Delivery of Lens in its Capsule (Continued)....1283
Fig. 650. Straight Delivery of Lens in its Capsule (Continued)....1284
Fig. 651. Straight Delivery of Lens in its Capsule (Concluded)....1284
Fig. 652. Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule 1285
Fig. 653. Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule (Continued)....1285
Fig. 654. Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule (Continued)....1285
Fig. 655. Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule (Continued)....1285
Fig. 656. Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule (Continued)....1286
Fig. 657. Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule (Concluded)....1286

PART VI, CHAPTER X.

DISCISSION, RECLINATION AND MATURATION OF CATARACT WITH SOME OTHER OPERATIONS ON THE CRYSTALLINE LENS.

Fig. 658. Discission of the Left Eye. Puncture Behind the Limbus....1296
Fig. 659. Discission Through the Clear Cornea....1297
Fig. 660. Teale's Suction Apparatus for the Aspiration of Cataract....1298
Fig. 661. Bowman's Syringe-pump for the Aspiration of Soft Cataract..1299
Fig. 662. Agnew's Bident for the Extraction of Dislocated Lenses....1311
Fig. 663. North Indian Instruments Used by the "Suttiahs" for Couching 1313
Fig. 664. Reclination (Scleronyxis Anterior) with Preliminary Iridectomy. (After Axenfeld)....1317

Page

Fig. 665. Anterior Chamber Irrigator for Use in the Extraction of Immature Cataract 1319
Fig. 666. Simple Anterior Chamber Irrigator Readily for Use in the Extraction of Immature Cataract 1319

PART VI, CHAPTER XI.

OPERATIONS FOR AFTER-CATARACT.

Fig. 667. Cheselden's Knife-Needle. (After Sharp) 1326
Fig. 668. Hays' Knife-Needle 1326
Fig. 669. Ziegler's Knife-Needle 1327
Fig. 670. Knapp's Knife-Needle 1327
Fig. 671. Falciform Knife-Needle 1328
Fig. 672. Post's Knife-Needle 1328
Fig. 673. Weeks' Knife-Needle 1329
Fig. 674. Risley's Knife-Needle 1329
Fig. 675. Chandler's Electric Illuminator Attached to Fixation Forceps. 1333
Fig. 676. Electric Spud-handle Used as Illuminator for Knife-Needle. ... 1334
Fig. 677. Sweep of Needle to Follow Curve When Piercing Cornea. (Weeks) 1335
Fig. 678. Contact with Capsule When Curved Needle is Employed. (Weeks) 1336
Fig. 679. Bowman's Stop-Needle 1337
Fig. 680. Entrance Through the Sclera for Division of After Cataract. (Meller) 1338
Fig. 681. Adams' Operation and Resulting Opening. (After Lawrence). 1339
Fig. 682. Adams' Iris Scalpel 1339
Fig. 683. Kuhnt's Operation 1340
Fig. 684. Ziegler's Iridotomy for After-Cataract 1341
Fig. 685. Ziegler's Operation 1342
Fig. 686. Maunoir's Scissors 1343
Fig. 687. Noyes' Iridotomy Scissors 1344
Fig. 688. de Wecker's Iridotomy Scissors 1345
Fig. 689. Two Forms of Iridotomy by Means of de Wecker's Iridotomy Scissors. (de Wecker) 1346
Fig. 690. Graefe Iridotomy Knife or Bent Broad Needle 1346
Fig. 691. Stevenson's Capsule Punch 1347

PART VI, CHAPTER XII.

OPERATIONS ON THE RETINA.

Fig. 692. Diagrammatic Section of the Eyeball, Showing Surgical Relations of the Retina 1347
Fig. 693. Points of Election 8-12 mm. from Sclero-corneal Junction, between Tendinous Insertions of the Straight Muscle, for Bulbar Punctures and Incisions 1351
Fig. 694. The Incision in Scleral Puncture 1359
Fig. 695. Schöler's Instruments for Intraocular Injection 1370
Fig. 696. Pflüger-Eissen Syringe for Intravitreous Medication in Separation of the Retina 1372
Fig. 697. Deutschmann's Syringe (Canula-knife) for Intravitreous Injections 1377
Fig. 698. Deutschmann's Knives for the Bisection Operation in Detached Retina 1378
Fig. 699. Deutschmann's Bisection Operation for Detached Retina 1379
Fig. 700. Deutschmann's Bisection Operation 1380

PART VI, CHAPTER XIII.

VARIETIES OF BLEPHAROPLASTY. OPERATIONS FOR ECTROPION, CANTHOPLASTY, TARSORRHAPHY AND FOR RESTORATION OF THE CUL-DE-SACS.

Page

Fig. 701. Agnew's Cantholysis, or Modification of von Ammon Canthoplasty 1396
Fig. 702. Walther's External Tarsorrhaphy 1398
Fig. 703. Goyanes' Operation for Restoration of an Eyebrow. First Stage 1399
Fig. 704. Goyanes' Operation for Restoration of an Eyebrow. Second and Final Stages 1399
Fig. 705. Fuchs' Operation for Tarsorrhaphy....1400
Fig. 706. Graefe's Operation for Tarsorrhaphy....1400
Fig. 707. Position of Sutures, Before Tying, in the Arlt Operation....1401
Fig. 708. Bossalino's Tarsorrhaphy 1402
Fig. 709. Author's Case of Total Ectropion....1411
Fig. 710. Author's Case of Complete Restoration of Entire Lower Lid One Month After Operation....1412
Fig. 711. Snellen's Operation for Ectropion, Showing Position of Suture.1413
Fig. 712. Ziegler's Galvano-puncture for Ectropion....1414
Fig. 713. Argyll-Robertson's Operation for Mechanical Ectropion....1415
Fig. 714. The Fox Operation for Ectropion....1416
Fig. 715. Adams' Operation for Ectropion. (After Beard)....1417
Fig. 716. von Ammon's Modification of Adams' Operations for Ectropion. (After Beard) 1417
Fig. 717. Walther's Operation for Ectropion. (After Beard)....1418
Fig. 718. Kuhnt's Combined Operation for Ectropion....1418
Fig. 719. Kuhnt's Operation for Ectropion. First Stage. (After Beard) 1419
Fig. 720. Kuhnt's Operation for Ectropion. Second Stage. (After Beard) 1419
Fig. 721. Müller's Operation for Ectropion. First Stage. (After Beard) 1420
Fig. 722. Müller's Operation for Ectropion. Second Stage. (After Beard) 1420
Fig. 723. Beard's Operation for Atonic Ectropion....1420
Fig. 724. Dieffenbach's Operation for Ectropion. First Stage. (After Beard) 1421
Fig. 725. Dieffenbach's Operation for Ectropion. Second Stage. (After Beard) 1421
Fig. 726. Szymanowski's Operation for Ectropion. First Stage....1421
Fig. 727. Szymanowski's Operation for Ectropion. Second Stage. (After Beard) 1422
Fig. 728. Dieffenbach's Operation for Ectropion of the Lower Lid. First Stage. (After Beard)....1422
Fig. 729. Dieffenbach's Operation for Ectropion of the Lower Lid. (Second Stage. (After Beard)....1423
Fig. 730. Wharton Jones' Operation for Ectropion. First Stage. (After Beard) 1423
Fig. 731. Wharton Jones' Operation for Ectropion. Second Stage. (After Beard) 1424
Figs. 732, 733, 734. Graefe's Operation for Cicatricial Ectropion. (After Beard) 1425
Fig. 735. de Wecker's Procedure for the Relief of Ectropion of the Lower Lid 1426
Figs. 736, 737. Dieffenbach's Blepharoplasty in the Removal of a Growth. (After Beard) 1427
Figs. 738, 739, 740. Harlan's Operation for Ectropion. (After Beard)..1428
Fig. 741. Terson's Operation for Ectropion. First Stage....1429
Fig. 742. Terson's Operation for Ectropion. Second Stage....1429
Fig. 743. Czermak's Modification of Dieffenbach's Operation....1430
Fig. 744. Burow's Operation for Ectropion. (After Beard)....1430

Page

Fig. 745. The True Operation for Ectropion.....1431
Fig. 746. von Ammon's Operation for Cicatricial Ectropion. (After Beard).....1431
Fig. 747. The Hotz Method in Blepharoplasty. (After Beard).....1432
Figs. 748, 749. Knapp's Sliding-Flap Operation for Ectropion. (After Beard).....1433
Fig. 750. Lagleyze's Operation in Ectropion of the Lower Lid.....1434
Fig. 751. Tweedy's Operation for Ectropion.....1434
Fig. 752. Denonvilliers' Operation for Ectropion.....1435
Fig. 753. The Argyll-Robertson Strap Operation for Ectropion.....1436
Fig. 754. Combination of Kuhnt and Dieffenbach Operations for Ectropion.....1436
Fig. 755. The Snydacker-Morax Method of Autoplasty. First Stage....1437
Fig. 756. The Syndacker-Morax Method of Autoplasty. Second Stage...1438
Fig. 757. The Snydacker-Morax Method of Autoplasty. Third Stage....1439
Fig. 758. Fricke's Operation for Cicatricial Ectropion. (After Beard).1440
Fig. 759. Blasius' Operation for Entire Lid Restoration. (After Beard).1441
Figs. 760, 761. Another Form of Blasius' Operation for Restoring the Entire Lid.....1442
Fig. 762. Denonvilliers' Flap Method of Blepharoplasty. (After Beard).1443
Fig. 763. Rollett's Blepharoplasty.....1443
Fig. 764. Richet's Blepharoplastic Method.....1444
Fig. 765. Incisions in the Businelli (1879) Operation. (Beard).....1445
Figs. 766, 767, 768, 769. Hasner's Blepharoplasty for Restoring Loss of Tissue at Either Canthus. (After Beard).....1446
Fig. 770. Landolt's Double Pedicled Flap Operation for Restoration of the Lower Lid.....1447
Fig. 771. Berger's Adaptation of the Italian Method of Heteroplasty....1448
Fig. 772. Anterior or Circumscribed Symblepharon.....1451
Fig. 773. Posterior or Partial Symblepharon.....1452
Fig. 774. Obliteration of the Cul-de-Sac from Shrinkage.....1452
Fig. 775. Total or Complete Symblepharon.....1453
Fig. 776. Arlt's Operation for Relief of Symblepharon. (After Beard).1454
Fig. 777. Symblepharon. Operation of Teale.....1455
Fig. 778. Teale-Knapp Operation for Symblepharon.....1456
Fig. 779. Snellen's Blepharoplasty for the Relief of Symblepharon.....1460

PART VI, CHAPTER XIV.

OPERATIONS FOR THE RELIEF OF TRICHIASIS, ENTROPION, PTOSIS AND EPICANTHUS—REMOVAL OF TUMORS OF THE EYELIDS.

Fig. 780. Lid Plates of Right Eye Dissected Out. (After Spalteholz)..1466
Fig. 781. Musculus Orbicularis Palpebrarum.....1468
Fig. 782. Muscle of Horner. (After Poirier and Charpy).....1469
Fig. 783. Septum Orbitale. (After Spalteholz).....1472
Figs. 784, 785. Gaillard-Arlt Suture for Spastic Entropion.....1478
Figs. 786, 787. Snellen's Suture for Entropion.....1479
Figs. 788, 789. Operation for Spastic Senile Entropion.....1481
Fig. 790. Janson's Operation for Spastic Entropion.....1482
Fig. 791. Graefe's Operation for Entropion.....1484
Fig. 792. Panas' Operation for Senile Spastic Entropion.....1485
Figs. 793, 794. Flarer-Stellwag Operation for Entropion.....1488
Figs. 795, 796, 797. Transplantation of Bed of Hair Follicles by Method of Jaesche-Arlt.....1490
Fig. 798. Landolt's Operation for Trichiasis.....1492
Figs. 799, 800. Spencer Watson's Operation for Complete Trichiasis. First Stage.....1494
Figs. 801, 802. Spencer Watson's Operation for Complete Trichiasis. Second Stage.....1495
Figs. 803, 804. Spencer Watson's Operation for Complete Trichiasis. Third Stage.....1495
Figs. 805, 806. Spencer Watson's Operation for Partial Trichiasis.....1496
Fig. 807. Operation of Nicati for Trichiasis.....1497

Page
Fig. 808. Operation of Gayet for Trichiasis....1498
Fig. 809. Operation of Dianoux for Entropion. First Stage....1499
Fig. 810. Operation of Dianoux for Entropion. Final Stage....1499
Fig. 811. Operation of Van Millingen for Entropion....1500
Figs. 812, 813. Operation of Mutermilch for Entropion....1501
Figs. 814, 815. The Hotz Operation for Entropion....1503
Figs. 816, 817. Operation of Green for Entropion....1507
Figs. 818, 819. Operation of Ewing for Entropion....1508
Fig. 820. Operation of Williams for Entropion....1509
Figs. 821, 822. Operation of Lagleyze for Entropion....1510
Figs. 823, 824. Operation of Snellen for Entropion....1512
Figs. 825, 826. Operation of Panas for Entropion....1514
Fig. 827. Beard's Operation for Entropion. Vertical Section....1516
Fig. 828. Wilder's Double Adjustable Entropion Knife....1518
Figs. 829, 830. Dransart's Operation for Ptosis....1525
Fig. 831. Pagenstecher's Operation for Ptosis....1527
Fig. 832. Mules' Operation for Ptosis....1528
Fig. 833. Worth's Operation for Ptosis....1529
Fig. 834. Harman's Operation for Ptosis....1531
Figs. 835, 836. deWecker's Operation for Ptosis....1532
Fig. 837. Hess' Operation for Ptosis....1533
Figs. 838, 839. Panas' Operation for Ptosis....1535
Figs. 840, 841. Allport's Operation for Ptosis....1537
Fig. 842. Grimsdale's Modification of Panas' Operation....1538
Figs. 843, 844. Tansley's Operation for Ptosis....1539
Figs. 845, 846. Rollet's Operation for Ptosis....1540
Fig. 847. Angelucci's Operation for Ptosis....1543
Fig. 848. Operation of Sourdille for Ptosis....1544
Figs. 849, 850. Operation of Eversbusch for Ptosis....1546
Fig. 851. Operation of Wolff for Ptosis....1548
Fig. 852. Lapersonne's Operation for Ptosis....1549
Fig. 853. Operation of de Grandmont for Ptosis....1552
Figs. 854, 855. Beard's Operation for Ptosis....1554
Fig. 856. Wilder's Operation for Ptosis....1556
Figs. 857, 858. Operation of Motais. First Stage....1558
Figs. 859, 860. Operation of Motais. Second Stage....1559
Figs. 861, 862. Operation of Motais. Final Stage....1560
Fig. 863. Parinaud's Operation for Ptosis....1561
Fig. 864. von Ammon's Operation for Epicanthus. (Rhinorraphy)....1564
Fig. 865. Desmarres' Operation for Epicanthus....1565
Fig. 866. Berger's Operation for Epicanthus....1566
Fig. 867. Rogman's Operation for Epicanthus....1567
Fig. 868. Agnew's Operation for Chalazion....1570

PART VII, CHAPTER I.

OPERATIONS ON THE LACHRYMAL APPARATUS.

Fig. 869. The Lachrymal Apparatus. Showing the Nasal Relations. (After Quain)....1576
Fig. 870. Various Naso-Lachrymal and Canaliculus Knives....1582
Fig. 871. Bowman's Naso-Lachrymal Probes....1585
Fig. 872. Vertical Introduction of the Canaliculus Probe or Dilator into the Punctum. (Meller)....1586
Fig. 873. Introduction (Second Step) of the Calaniculus Probe, Dilator or Knife Point into the Lachrymal Sac....1587
Fig. 874. Bowman's Probe in Place After Passage Along the Canaliculus into the Sac and Nasal Duct....1588
Fig. 875. Theodbald's Lachrymal Probes....1589
Fig. 876. Anel's Syringe for Irrigation of the Naso-Lachrymal Duct....1591
Fig. 877. Silver Tube with Horizontal Shoulder. (Bickerton)....1596

PART VII, CHAPTER II.

OPERATIONS ON THE NOSE AND ITS ACCESSORY SINUSES FOR THE RELIEF OF OCULAR SYMPTOMS.

Page

Fig. 878. View of Frontal Sinus and Neighboring Cavities in Their Relation to the Orbit....1620
Fig. 879. View Showing the Two Positions in Probing the Fronto-Nasal Duct....1621
Fig. 880. Author's Accessory Sinus Suction Apparatus....1622
Fig. 881. Author's Irrigating Apparatus and Cannulæ....1624
Fig. 882. Van Struycken Nasal Punch Forceps....1625
Fig. 883. Casselberry's (Serrated) Nasal Scissors....1625
Fig. 884. Lack's Knife....1626
Fig. 885. The Sluder Knife....1626
Fig. 886. Krause Nasal Snare....1627
Fig. 887. Ballenger Swivel Turbinotome....1627
Fig. 888. Myles Nasal Punch Forceps....1628
Fig. 889. Stevenson's (Bernay) Nasal Tampon....1628
Fig. 890. Modified Burr Carrier. Modified Burr. Flexible Spiral Sheath. (Ingals)....1629
Fig. 891. Drainage Tube Introducer. Gold Drainage Tube. (Ingals)....1629
Fig. 892. Frontal Sinus Probes and Handle. (Ingals)....1630
Fig. 893. Gauze Packer. Bulb for Medication through Gold Drainage Tube. (Ingals)....1630
Fig. 894. Ingals' Intranasal Frontal Sinus Operation....1631
Fig. 895. Instruments for the Intranasal Frontal Sinus Operation. (Halle)....1632
Fig. 896. Frontal Sinus Probes. (Good)....1633
Fig. 897. Frontal Sinus Protectors. (Good)....1633
Fig. 898. Frontal Sinus Chisels. (Good)....1634
Fig. 899. Frontal Sinus Rasps, Right and Left. (Good)....1634
Fig. 900. Frontal Sinus Drain. (Good)....1634
Fig. 901. Good Intranasal Frontal Sinus Operation....1635
Fig. 902. The Hajek-Luc Radical Frontal Sinus Operation....1636
Fig. 903. Killian Radical Frontal Sinus Operation....1638
Fig. 904. Hajek Modified Killian Radical Frontal Sinus Operation....1640
Fig. 905. Prince's Turbinal Forceps....1643
Fig. 906. Golovine's Osteoplastic Frontal Sinus Operation....1644
Fig. 907. Relation of Maxillary Sinus to the Orbit....1646
Fig. 908. Relation of Eyeball to the Lachrymal Apparatus and the Nose....1648
Fig. 909. Myles Antrum Trocar and Author's Attachment for Irrigator....1649
Fig. 910. Dickson's Antrum Trocar....1649
Fig. 911. Author's Treatment Bottle....1650
Fig. 912. Bishop's Antrum Trephine....1651
Fig. 913. Modified Mikulicz Intranasal Operation upon the Antrum of Highmore....1652
Fig. 914. Antro-Nasal Chisel. Right and Left. (Stein)....1653
Fig. 915. Antrum Saws. Right and Left. (Vail)....1653
Fig. 916. Method of Intranasal Removal of the Naso-Antral Wall....1654
Fig. 917. Antrum Chisels. (Corwin)....1655
Fig. 918. Reversible Antrum Punch. (Ostrum)....1655
Fig. 919. Antrum Punch. (Roe)....1656
Fig. 920. Klaar Electric Headlight....1658
Fig. 921. The Denker Radical Operation upon the Maxillary Sinus....1660
Fig. 922. Robertson's Method of Cutting the Flap of Nasal Mucous Membrane in the Radical Operation upon the Antrum of Highmore....1661
Fig. 923. Intranasal Window Resection of Nasal Duct. (After West)....1663
Fig. 924. Double-valved Syringe....1664
Fig. 925. Relation of Ethmoidal Cells and Nasal Accessory Sinuses to the Orbit....1666
Fig. 926. Ethmoidal Instruments....1669

Page

Fig. 927. Ballenger's Set of Ethmo-Turbinal Knives and Sphenoid Curette 1670
Fig. 928. First Step of Ballenger Operation for Removal of Ethmoidal Cells with the middle Turbinal....1671
Fig. 929. Second Step in Ballenger Ethmoid Operation....1672
Fig. 930. Final Step in Ballenger's Ethmoid Operation....1673
Fig. 931. Relation of Optic Chiasm, Optic Nerves and Eyeball to the Nasal Accessory Sinuses....1675
Fig. 932. Probing the Sphenoidal Sinus....1676
Fig. 933. Set of Sphenoid Instruments....1677
Fig. 934. Hajek Spenoid Punch....1680
Fig. 935. Spenoidal Sinus Operation. Removal of Anterior Wall of Spenoid Sinus with the Hajek Forceps. (After Ballenger)..1681

PART VIII.

OPERATIONS ON DISTANT ORGANS FOR THE RELIEF OF EYE SYMPTOMS.

Fig. 936. Subcortical Tumor....1687
Fig. 937. Author's Method of Controlling Hemorrhage from Vessels of the Scalp by Means of a Large Rubber Band....1693
Fig. 938. Curtis-Halstead Table....1694
Fig. 939. Krause's Flexible Sound for Exploration of the Subdural Space 1699
Fig. 940. The Subtemporal, Submuscular, Decompression Operation of Cushing 1702
Fig. 941. Subtemporal Decompression....1703
Fig. 942. Method of Ligating the Occipital Sinus and Overlying Strip of Dura 1708
Fig. 943. Serous Cyst of the Cerebellum, Near the Cerebello-Pontine Angle. (Author's Case)....1709
Fig. 944. Removal of Hypophysis Tumor by Way of the Oro-Nasal Route. First Stage....1712
Fig. 945. Removal of Hypophysis Tumor by Way of the Oro-Nasal Route. Second Stage....1715
Fig. 946. Removal of Hypophysis Tumor by Way of Oro-Nasal Route. Third Stage....1718
Fig. 947. Photograph of Patient Two Months After Removal of Tumors of the Hypophysis Through the Oro-Nasal Route....1719
Fig. 948. Cranial Puncture Points. (Neisser and Pollock)....1729
Fig. 949. Spinal Puncture....1731
Fig. 950. Method of Puncture for Spinal Drainage....1732
Fig. 951. Topographical Relations for Spinal Puncture, According to Tuffier 1733
Fig. 952. Diagram of Lumbar Puncture....1735
Fig. 953. Parathyroid Glands in Their Normal Relations to the Thyroid Glands. (After Ochsner)....1742
Fig. 954. Kocher's Transverse or Collar Incision in Strumectomy....1744
Fig. 955. Kocher's Angular Incision in Unilateral Resection of the Thyriod Gland....1747
Fig. 956. Unilateral Thyroidectomy Through Kocher's Angular Incision.1749
Fig. 957. Exothyropexy in Graves' Disease....1755
Fig. 958. Mayo's Incision for Ligation of the Superior Thyroid Arteries in Exophthalmic Goitre....1756
Fig. 959. Unilateral Thyroidectomy. Ligation of Superior Thyroid Vessels After Dislocation of the Gland....1758
Fig. 960. The Cervical Sympathetic Nerve and Ganglion....1761
Fig. 961. The Middle Cervical Ganglion. (After Bryant)....1762
Fig. 962. Inferior Cervical Ganglion. (After Bryant)....1764
Fig. 963. Relations of Structures Concerned in Removal of the Third Cervical Sympathetic Ganglion....1766

Page
Fig. 964. Case of Bilateral Pulsating Exophthalmos Due to Basal Skull Fracture 1767
Fig. 965. Pulsating Exophthalmos. (Author's Case) 1768
Fig. 966. Relations of Common, External and Internal Carotids to Superior Thyroid and Other Neighboring Structures 1770
Fig. 967. Dissection Showing Relations of Common Carotid to the Omohyoid Muscle 1771
Fig. 968. Relations of Carotid Arteries and Jugular Veins to the Ocular Region 1772

LIST OF INSERT AND COLOR ILLUSTRATIONS

PART III, CHAPTER IV.

Plate I. Transillumination of a Case of Sarcoma of the Choroid.
Plate II. Transillumination of the Normal Eye.
Plate III. Transillumination of an Old Wound of the Ciliary Body.
Plate IV. Modification of Sweet's Chart Plotting the Location of Foreign Bodies in the Eye and Orbit.

PART IV, CHAPTER III.

Plate V. Orbital Fascia and Capsule of Tenon. Vertical Section in Line of the Optic Nerve.

PART V.

Plate VI. Nerves, Muscles and Other Contents of the Orbit.

PART VI, CHAPTER VI.

Plate VII. Cyst of the Iris.
Plate VIII. Operations on Cyst of the Iris.

PART VI, CHAPTER VII.

Plate IX. Lymph Passages of the Eye (Schematic).
Plate X. Peripheral Nerves and Blood-Vessels of the Eyeball.
Plate XI. Meridional Section of Ciliary Region of the Eyeball.

CHAPTER XIII.

Plate XII. The Veins and Arteries of the Eyelids. (After Testut).

CHAPTER XIV.

Plate XIII. Vertical Section through the Upper Eyelid, showing also course of Vessels and Nerves. (After Merkel and Kallius.)

PART VII, CHAPTER I.

Plate XIV. Relations of the Lachrymal Sac.
Plate XV. Hoffman's Improvement on Bowman's Operation of Slitting the Canaliculus.
Plate XVI. Excision of the Lachrymal Sac. First, Second, Third and Fourth Stages.
Plate XVII. Excision of the Lachrymal Sac. Fifth, Sixth, Seventh and Eighth Stages.

PART VII, CHAPTER II.

Plate XVIII. Horizontal Section of the Left Orbit.

GENERAL INDEX

References to a surgical procedure or appliance will be most readily found under the name of the surgeon to whom it is generally attributed.

Both complete and partial titles of chapters appear and are cross-indexed, with the names of their authors, in small capitals.

For a list of illustrations as they appear in each chapter, see pp. 1773 to 1794.

A

Abadie's ciliarotomy in glaucoma, 1112.
  iridoectomy, 1054, 1055.
  keratoconus operation, 967.
  retinal detachment operation, 1364.
  staphylotomy, 1061, 1062.
Ablatio retinæ; see Retina, detached.
Ablation scissors, 500.
Abscess of lids, 1568.
  orbital, 821.
Abscission, 575, 582, 585, 586, 589.
Acid, carbolic, 400, 451.
Acids, burns from, 807.
Acoin, 405.
Acrel's pterygium operation, 865.
Adams' after-cataract operation, 1339.
  ectropion operation, 1416, 1417.
  iris scalpel, 1339.
  keratoconus operation, 962, 1008.
Addario's trachoma operation, 914.
Adductors, secondary, tenotomy of, 693.
Advancement, capsule, 722, 723, 744.
  complications of, 276.
  forceps, 492, 494, 677.
  hook, 486.
  operations, 672, 705, 734.
Æsculapius, 20.
After-cataract, 1242.
  avulsion of, 1337.
  complicated, 1338.
  instruments for, 1325.
  operations, hemorrhage following, 1347.
AFTER-CATARACT OPERATIONS; by M. STANDISH, 1320.
  after-treatment, 204.
AFTER-TREATMENT, BY E. C. ELLETT, 235
Agnew's advancement operation, 709.
  after-cataract operation, 1337.
  bident, 501, 1311.
  cantholysis, 1395.
Agnew's capsulotomy, 1204.
  chalazion operation, 1569.
  dislocated lens operation, 1310.
  enucleation method, 573.
  lachrymal knife, 474, 475, 1582.
  iridectomy knife, modified, 868.
  pannus operation, 918.
  peritomy, 949.
Alkalies, burns from, 807.
ALLPORT, FRANK; OPERATIONS FOR ENUCLEATION OF THE EYE AND THEIR SUBSTITUTES, 539.
Allport's entropion suture, 1479.
  enucleation operation, 564.
  irrigator, 508.
  ptosis operation, 1536, 1537.
  treatment tray, 261.
ALT, ADOLF: IRIDECTOMY, IRIDOTOMY AND SOME ALLIED OPERATIONS, 1024.
Alypin, 405, 423.
  infiltration anesthesia, 397.
Amaurosis, tests for simulation of, 91.
Ambidexterity, 187.
Amblyopia, tests for simulation of; 91.
America, ophthalmology in, 38.
Ametropia operations, 467.
v. Ammon, 37.
v. Ammon's ectropion operation, 1416, 1431.
  epicanthus operation, 1563, 1564.
v. Ammon-Agnew canthoplasty, 1395.
Amphitheater operations, 531.
Ampullæ, 413.
Anagnostakis' entropion operation, 1504.
Analgesia, 765.
  see also Anesthesia.
Andrew's conjunctival sac operation, 834.
  intracapsular cataract extraction, 1255.

Andrew's syringe, 511.
Anel, 32.
Anel's lachrymal syringe, 505, 1591.
Aneson, 406.
Anesthesia, 764.
  ganglion, 389.
  in cataract extraction, 1163.
    enucleation, 547.
    iridectomy, 1087.
ANESTHESIA IN OPHTHALMIC OPERATIONS; BY W. REBER, 377.
    roller operations, 892.
    orbital surgery, 819.
    strabismus operations, 675.
  infiltration, 395.
  intracutaneous, 400.
  mask, 379.
  mucous, 400.
  nerve trunk regional, 391, 392.
  regional, 388.
Anesthesin, 424.
Anesthetics, local, 421.
  miscellaneous, 403.
Aneurism, orbital, arterial ligation in, 840.
Angelucci's fixation method, 1186, 1187.
  ptosis operation, 1542, 1543.
Angiofibroma, removal of, 1572.
Angioma, orbital, 839.
  pulsating, arterial ligation in, 840.
  removal of, 1572.
Animals' eyes, transplantation of, 630.
Anterior chamber, hemorrhage into in cataract extraction, 1229.
  irrigator, 781, 1189, 1319.
Anthrax, 1568.
Antisepsis before operations, 205.
Antiseptics, 269, 438.
Antonelli's peripheral iritomy, 1085.
Antral walls, operations on, 1650.
Antro-nasal chisel, 1653.
Antrum chisels, 1655.
  curettes, 1669.
  punch, 1655, 1656.
  saws, 1653.
  trephine, 1651.
  trocars, 1649.
  see also Maxillary sinus.
Applications, 265.
  of heat and cold, 426.
Applicators, 250, 258, 259, 260.
Arabians, ophthalmology among, 18.
Argyll-Robertson's advancement suture, 715.
  ectropion operation, 1414, 1436.
v. Arlt's capsulotomy, 1204.
    cataract incision, 1153.
    cystotome, 1190.
    enucleation method, 572.
    epicanthus operation, 1564.
    iris-punch, 1054.
    pterygium operation, 865, 870.
v. Arlt's scalpel, 473.
    scissors-handled punch, 491.
    serrated loop, 485.
    symblepharon operation, 1454.
    tarsorrhaphy, 1399, 1401.
Armaignac's corneal tattooing operation, 1004.
Arnemann's intracapsular cataract extraction, 1249.
Arterial ligation in orbital disease, 839.
Arteries, thyroid; see Thyroid arteries.
Asepsis before operations, 205.
  of wounded eye, 756.
Asmus' sideroscope, 310.
Aspiration of cataract, 1297.
  of subretinal fluid, 1361.
Astigmatism after cataract extraction, 1245.
  operations for, 467.
Atresia, canalicular, 1580.
Atropin irritation, dermatitis and conjunctivitis, 1231.
Autoplastic palpebrale, 1497.
Autoplasty, 805, 1437, 1438, 1439.
Avicenna, 19.
Axenfeld's lachrymal sac retractor, 509.
  reclination, 1315, 1317.
Ayres' chalazion forceps, 496.

B

Babylon, malpractice in, 170.
Badal's keratoconus operation, 964, 1013.
Bader's anterior sclerotomy for glaucoma, 1081.
  cataract incision, 1151.
  keratoconus operation, 1010, 1012.
Bajardi's advancement suture, 716.
  peripheral iritomy, 1202.
  subconjunctival cataract extraction, 1224.
Ball's conjunctivoplasty, 992.
Ballenger's ethmoid cell operation, 1670, 1673.
  ethmo-turbinal knives, 1670.
  maxillary sinus operation, 1655.
  sphenoid curette, 1670.
  swivel turbinotome, 1627.
Bandages, 243, 419, 763.
Barck's capsulotomy, 1206, 1207.
  corneal trephine, 1004, 1005.
  entropion forceps, 503.
Barraquer's formation of stump after Mules' operation, 607.
Barrett's suturing operation, 611.
Barth, 32.
Barth's cataract knife, 1147.
Bartisch, George, 24.
Bartisch's enucleation operation, 550, 551, 552.
Basedow's disease, 1737.
Basso's reclinateur, 1256, 1257.
Bates' lachrymal syringe, 510.

Bath, sweat, 454.
Baumgarten's strabismus operation, 671.
Baxter's retractor, 489.
BEARD, CHARLES H.: VARIETIES OF BLEPHAROPLASTY, CANTHOPLASTY, TARSORRHAPHY AND OPERATIONS FOR RESTORATION OF THE CUL-DE-SACS, 1388.
Beard's advancement operation, 713.
blepharostat, 504.
blunt dissector, 488.
canaliculus ligature, 1584.
cautions on cataract operation, 1180.
cystotome, 476.
ectropion operation, 1418, 1420.
entropion operation, 1515.
exenteration knife-spatula, 488, 489.
extraction hooks, 486.
fixation forceps, 493, 494.
keratoconus operation, 971.
lid forceps, 502.
ptosis operation, 1554.
scalpel, 473.
sounds, 482, 483.
trachoma operation, 914.
Beck's paraffin syringe, 505.
Beck-Mueller paraffin injector, 441.
Becker's cystotome, 1190.
Beer, Joseph, 31, 32.
Beer's cataract incision, 1150.
knife, 480, 1147.
extraction, intracapsular, 1249.
iridotomy, 1045, 1046.
styles, 1593.
Belladonna, first employment of, 32.
BELL, JAMES HALL, AND HANSELL, HOWARD F.: OPERATIONS ON THE LACHRYMAL APPARATUS, 1574.
Bell's cataract knife, 1147.
Bell-Taylor's cataract incision, 1151.
Belt's formation of stump after Mules' operation, 606.
Bendz, 37.
Benedict's trachoma operation, 908.
Beranger's cataract incision, 1150.
knife, 1145, 1146, 1148.
Berger's binocular loup, 783.
epicanthus operation, 1565, 1566.
heteroplasty, 1447.
Berry's hypopyon treatment, 961.
lachrymal duct operation, 1594.
Beta-eucain, 404.
Bettremieux's cystotome, 1191.
Bickerton's styles, 1595, 1596.
Bident for extraction of dislocated lens, 1311.
Bier's hyperemia, 454.
Birnbacher's capsulotomy, 1213.
ptosis operation, 1526.
Bisection of vitreous and retina for detached retina, 1375, 1377, 1379.
Bishop's antrum trephine, 1651.
Bissell's preparation of the opening in Mules' operation, 592.
Bistouries, 474.
Bitzos' trachoma operation, 915.
Black's adjustable lid plate, 501, 502.
advancement suture, 716.
cataract knife, 481.
pterygium knife, 474.
Blascovics' suture, 914.
Blasius' lid restoration, 1441, 1442.
Bleeding; see Blood-letting; Hemorrhage.
Blepharoplasty, 1407, 1426, 1450.
BLEPHAROPLASTY, VARITIES OF; BY C. H. BEARD, 1388.
Blepharorrhaphy, 1398.
Blepharostats, 197, 238, 501, 504, 1026, 1185.
Blindness, tests for simulation of, 91.
"Blind spot," earliest demonstration of, 26.
Blizzard's lachrymal duct operation, 1594.
Blood-letting, 446, 456.
Boeckmann's entropion suture, 1479.
pannus operation, 919.
peridectomy, 950.
Boerhaave, 26.
Boettcher's chalazion punch-forceps, 495.
Boil; see Furuncle.
Bolton, James, 38.
Blisters, 452.
Bolton's strabismus operation, 670.
Bonnet, 37.
Bonnet's enucleation operation, 553, 556.
Borelli's grattage, 893.
staphyloma operation, 974.
trachoma operation, 884.
Borghetti's staphyloma operation, 981.
Borsch's artificial eyes, 640.
corneal tattooing operation, 1004.
operation for delayed implantation, 615.
Borysickiewicz' intracapsular cataract extraction, 1254.
Bossalino's tarsorrhaphy, 1401.
Bottle, treatment, 1650.
Bottles, wash, 758.
Boucheron's optico-ciliary neurotomy, 618.
ptosis operation, 1552.
Bougies in nasal duct obstruction, 1597.
Bourgeois' abscission method, 582.
corneal section downward, 1194.
tendon-tucking stitch, 724.
Bowman, 37.
Bowman's after-cataract operation, 1336.
canaliculus knife, 1582.
cataract incision, 1151.
dislaceration of detached retina, 1361.
fenestrated loop, 485.
iridenkleisis, 1057, 1058.
iridodesis, 965, 1009.
iridolysis, 1061.
iridotomy, 1045.
keratoconus operation, 967, 1010.

Bowman's lachrymal knife, 475.
naso-lachrymal probes, 1585.
probes, 481.
ptosis operation, 1545.
slitting of canaliculi, 1581.
stop needle, 478, 1337.
suction syringe, 1192, 1299.
Bowman-Panas tarsorrhaphy, 1400.
Boyer's cataract knife, 1147.
cystotome, 1190.
Boynton's needle-holder, 499.
Bradburne's iridectomy in glaucoma, 1108.
Bradford's magnet, 349.
Brain puncture, 1725.
tumor, 1701, 1709.

Brawley, Frank: Operations on the nose and its accessory sinuses for the relief of ocular symptoms, 1610.

Brawley's accessory sinus suction apparatus, 1622.
irrigating apparatus and cannulæ, 1624.
treatment bottle, 1650.
Briggs' ablation scissors, 500.
optic nerve scissors, 624.
tendon-folding instrument and operation, 730, 732.
Brisseau, Pierre, 26.
Broeckaert's paraffin injection, 442.
Brossage, 432, 884, 898.
Bruns' strabismus hook, 728.
Bull's operation for retinal detachment, 1364.
Buller's discission needle, 470.

Bulson, Albert E.: Development of operative skill in the surgeon, 179.

Bunge's exenteration spoon, 484.
Buphthalmos, 1076.
treatment of, 1104.
Burnett's glaucoma operations, 1107, 1131.
Burning, ocular signs of, 128.
Burns of eye, 282.
lids, 862, 806.
Burow's ectropion operation, 1430.
entropion operation, 1506.
Busanelli's blepharoplasty, 1445.
Busch's entropion operation, 1483.

Byers, W. Gordon M.: Preoperative technique of ophthalmic surgery, 205.

C

Cahn's suture, 914.

Callan, Peter A.: Discission, reclination and maturation of cataract with some other operations on the crystalline lens, 1289.

Callan's irrigator, 508.
Campbell's traumatic cataract procedure, 798.
roller forceps, 890.
Canaliculus, atresia of, 1580.
dilators, 481.
knives, 1582.
ligature of, 1584.
operations, 1580.
probes, 481.
Cannstadt's intracapsular cataract extraction, 1253.
Cannula, sphenoid, 1677.
Canulæ, 484.
Canthoplasty, 1394.
Canthorrhaphy, 1399.

Canthoplasty, tarsorrhaphy, etc., by C. H. Beard, 1388.

Capsular advancement, 722, 723, 744.
ligature, 726.
scissors, 490.
tissue, excision of, 743.
Capsule, advancement of, 744.
muscle with, 706.
anterior, removal of a portion of, 1211.
in cataract extractions, 1203.
anterior synechiæ of, 1073.
forceps, 491, 492, 494, 1213, 1214, 1270.
hooks, 487.
opening of in cataract extraction, 1174, 1208.
posterior, discission of, in cataract extraction, 1218.
puncture of, in cataract extraction, 1209.
preliminary rupture of, in cataract extraction, 1207.
punch, 1347.
rupture of during iridectomy, 1097.
Capsulo-lenticular extraction, East Indian methods of, 1259.
iridectomy in, 1281.
section in, 1274.
Capsulotomes, 476, 479, 1189, 1190, 1191.
Capsulotomy, 1174, 1203, 1206, 1230.
Carbolic acid, 400, 451.
Carbon dioxid snow, 400.
Caries of orbit, operations for, 846.
Carotid, common, ligation of, 1769.
internal, ligation of, 1771.
Carson's electric spud and knife-needle, 308.
Carter's iris or capsular scissors, 490.
Casa Amata's cataract knife, 1148.
Case law in U. S., 50.
Casselberry's nasal scissors, 1625.
Cassiani's intracapsular cataract extraction, 1258.
Cataphoresis, 449.
Cataract, ancient Greek treatment of, 20.
artificial ripening of, 1315.
Daviel's operation for, 27, 29.
delivery of, 1175.
detacher, 501.

CATARACT, DISCISSION, RECLINATION AND MATURATION OF; BY P. A. CALLAN. 1289.
early theories of, 26.
extraction, complications of, 279.
conjunctival flap for, 775.
historical review of, 1141.
iridectomy preparatory to, 1042.
CATARACT, EXTRACTION OF SENILE TYPE OF; BY C. A. WOOP, 1135.
Cataract extraction, open treatment after, 253.
retrociliary, 1225.
senile, accidents and complications of, 1226, 1238.
simple and combined, 1198.
forceps, 1225.
incisions, 1150, 1151, 1153, 1193.
CATARACT, INTRACAPSULAR EXTRACTION OF; BY D. W. GREENE, 1247.
knives, 477, 479, 1078, 1088, 1144, 1152, 1154, 1155, 1187, 1188, 1195, 1264, 1271, 1326, 1327, 1328, 1329, 1333.
lid retractor, 487.
maturation of, 1315.
Saunders' operation for, 37.
secondary; see After-cataract.
senile, 1135.
sub-conjunctival extraction of, 1221, 1222.
suction removal of, 1297.
traumatic, 796.
von Graefe's and de Wecker's operations for, 28.
Caustics, 451.
injuries to eye from, 282.
in corneal ulcer, 930.
Cauterization, chemical, of corneal ulcer, 929.
Cautery, 450.
appliances, 274, 506, 510, 955.
corneal, 778.
electric, 284.
handle, 273.
history of, 286.
in corneal staphyloma, 975.
corneal ulcer, 932.
evisceration, 588.
keratoconus, 968, 1011.
spastic entropion, 1480.
trachoma, 900.
points, 274, 286, 933, 935.
for keratoconus, 1012.
Cavernous sinus, operations on, 1680.
Cavignet's cataract extraction, 1151.
Celsus, 17, 20.
Celsus' pterygium operation, 864.
Cerebellar cyst, 1709.
Cerebral puncture, 1725.
tumor, operation for, 1701.
Cervical sympathetic, operations on, 1760.
Chalazion clamp, 502.
forceps, 495, 496.
Chalazion operations, 1569.
spoons, 484.
Chalk's bottles, 410.
Chalot's canthoplasty, 1397.
Chamber, anterior; see Anterior chamber.
CHANDLER, H. B.: SURGICAL TREATMENT OF CORNEAL ULCER AND FISTULA. 923.
Chandler's cataract operation, 1201.
electric light, 1331, 1333.
Charles' operation for stilicidium, 1580.
Check ligaments, 663.
division of, 742.
Chelius, Max, 35.
Cheselden, William, 28, 31.
Cheselden's after-cataract incision, 1328.
operation, 1339.
iridotomy, 1044.
knife-needle, 1326.
Chevallereau's abscission, 579.
Chevallereau and Polack's method of tattooing the cornea, 998.
Chevallereau's combined transverse keratotomy, 961.
Chevrier and Cantonnet's local anesthesia, 391, 392.
Chibret's exenteration operation, 581.
sclero-cyclo-iridic puncture in glaucoma, 1085.
Chisel, antro-nasal, 1653.
antrum, 1655.
frontal sinus, 1634.
Chisholm's optico-ciliary neurotomy, 625.
Chloroform in opthalmic operations, 380.
Choked disc; see Disc, choked.
Choroid, detachment of after cataract extraction, 1243.
Choroid, prolapse of, 794.
transillumination of, 302.
Choroido-retinal galvano-puncture in retinal detachment, 1363.
Christiaen's intracapsular cataract extraction, 1249.
Cicatrisotomie for glaucoma, 1082.
Cicatrix, cystoid, 1116.
abscission of, 772.
filtering, 1108.
Cilia, correction of faulty positions of, 1475, 1486.
forceps, 492.
Ciliarotomy in glaucoma, 1112.
Ciliary body, inflammation of, 1074.
Ciliary body, prolapse of, 794.
transillumination of, 302.
region, injuries at, 786.
Circumcision conjunctival, 947.
Cirincione's lachrymal sac, operation, 1603.
Civil law in U. S., 51.
Claiborne's cataract knife, 481, 1195.
formation of eyeball stump, 606.
roller forceps, 890.

Clamp, double hook, 678.
eyelid, 501.
lachrymal sac, 509.
muscle, 678.
tendon, 730.
Clark's double advancement hook, 727, 728.
Clark's speculum, 1186, 1269.
Clarke's formation of stump after enucleation, 567.
Claus' maxiliary sinus operation, 1657.
Cluckie's subconjunctival extraction of cataract, 1224.
Coakley's antrum curette, 1669.
frontal sinus operation, 1641.
Coburn's modified Pacquelin cautery, 511.
Cocain anesthesia, 401.
infiltration, 395.
Coccius' conjunctival sutures, 865.
keratome, 476.
Coffin's frontal sinus operation, 1641.
Cogan's advancement stitch, 721.
Cohen's expression forceps, 891.
Colburn's muscle-tucking operation, 725.
partial fixation operation, 745.
Cold applications, 266, 426.
Color blindness, test for, 523.
Collins' iris forceps, 792.
Collodions, 420.
Collyria, 409.
bottle, 229.
Come's cataract extraction, 1151.
Common law in U. S., 50.
Complications, postoperative, 269.

COMPLICATIONS, POST-OPERATIVE, TREATMENT OF; BY E. C. ELLETT, 235.

Compresses, 449.
Conjunctiva, diseases of, due to nasal disease, 1614.
excision of in trachoma, 908.
extirpation of, 833.
foreign bodies in, 766.
injuries to, 281, 766.
operations utilizing, 768.
preoperative sterilization of, 213.
signs of injuries of, 105.
surgical anatomy of, 881, 1393.
tumors of, 643.
Conjunctival douches, 413.
Conjunctival flaps, 772.
in cataract extraction, 1167, 1178.
suture after cataract extraction, 1219.
Conjunctivoplasty, 770, 771, 992, 994, 995, 996, 997, 998.

CONJUNCTIVOPLASTY AND OTHER OPERATIONS ON THE CORNEA; BY C. A. OLIVER, 942.

Conradi's discission of cataract, 1291.
Convergence, deficient and excessive, choice of operation for, 751.
Cooper's maxillary sinus operation, 1650.
styles, 1594, 1596.
Corelysis, 1058.
Coover's grattage, 895.
Copiopia, tests for simulation of, 91.
Cornea, abscission of, 575, 577.
alterations in, due to nasal disease, 1615.
Cornea, circumcision of, 918, 919, 920, 947, 949.
collapsed, in cataract extraction, 1229.
conical, history of procedures for, 1008.
iridenkleisis for, 1057, 1058.
galvano-cautery in, 290.
non-surgical procedures in, 1011.
operations for, 961.
pathology of, 1007.

CORNEA, CONICAL, OPERATIONS FOR; BY W O. NANCE, 1006.

defects of, operations for, 769.
descemetocele of, operation for, 775.
fistula of, 772, 775, 938.
foreign bodies on, 781.
inflammation of, post-operative, 273, 1238.
injuries of, 281.
signs of, 105.
surgical treatment of, 777.
opacity of, nodular, 947.
post-operative, 1238.
tattooing in, 996.

CORNEA, OPERATIONS ON (PARACENTESIS, KERATOTOMY, CONJUNCTIVOPLASTY, ETC.); BY C. A. OLIVER, 942. 769, 776, 779, 942, 955, 957, 961, 1006, 1013.
history of, 923.
paracentesis of, 950.
in glaucoma, 1078.
in retinal embolism, 1386.
scarification of, 942.
split, in cataract extraction, 1228.
staphyloma of, 772.
operations on, 971.
surgical anatomy of, 924.
tattooing of, 996.
transillumination of, 301.
transplantation of, 1013.
tumors of, 643.
Cornea, ulcer of, 778, 923, 926, 939, 944, 1042.
wounds of, 105, 281, 777.
Corneal curettes, 928.
epithelium, removal of, after cataract extraction, 1227.
incisions, complications of, 277.
in cataract extraction, 1150, 1151, 1152, 1153, 1193, 1274, 1275.
intracapsular cataract extraction, 1279.
knives, 474, 476, 1047, 1187.
method of holding, 1090.
masseur, 432.
microscope, 517.
section; see Corneal incision.

Corneal suture, 777.
after cataract extraction, 1220.
trephine, 1004, 1022.

CORNEAL ULCER AND FISTULA, SURGICAL TREATMENT OF; BY H. B. CHANDLER, 923.

cauterization in, 778.
iridectomy in, 1042.
paracentesis in, 944.
rodent, 937.
stains for, 939.
surgical treatment of, 926.
Cornea-scleral margin, injuries to, 785.
"Corneotomy," 580.
Cortical matter, expulsion of in cataract extraction, 1176.
Costume, operating, 217.
Couching, 1312.
instruments, 1313.
Counter-irritants, 450.
Couper's probes, 482.
Court systems in England, 54.
in France, 55.
in Germany, 57.
in Italy, 59.
in United States, 44.
Crainiciann's retrociliary cataract extraction and instruments, 1225.
Cranial puncture, 1725.
Craniectomy, exploratory and decompressive, 1692.
Criminal law in U. S., 51.
Critchett's abscission of the cornea, 577.
advancement operation, 705.
cataract incision, 1151.
knife, 481.
fixation forceps, 492, 494.
iridenkleisis, 1057.
iridodesis, 965, 1009.
keratoconus operation, 969, 1010.
staphyloma operation, 983, 985, 986.
strabismus operation, 670.
synechiæ scissors, 499.
Crochet neurotome, 559, 560, 625.
Crossbill forceps, 493.
Crystalline lens; see Lens.
Cuignet's test for simulated blindness, 95.
Culbertson's iricystome, 479.
Cul-de-sac, restoration of, 1462.

CUL-DE-SACS, OPERATION FOR RESTORATION OF; BY C. H. BEARD, 1388.

Cupping, wet, 446.
Curettes, antrum, 1669.
cataract, 1263.
corneal, 928.
sphenoid, 1670.
suction, 501.
Curetting for corneal ulcer, 928.
Curtis-Halstead operating-table, 1694.
Cusco's cystotome, 1190.
Cushing's decompression operation, 1702.
hypophysis operation, 1716.
Cyclitis, serous, 1074.
Cyclodialysis, 1123.
Cyclotomy, hyposcleral, 1122.
Cyst, cerebellar, 1709.
cerebral, operation for, 1705.
epibulbar, 643.
orbital, extirpation of, 837.
Cysticercus, operations for, 858.
Cystotomes, 475, 479, 1189, 1190, 1191.
Cystotomy, 1174, 1203.
Cystotomy, insufficient, 1230.
Cystotomy, preliminary, 1206.
Czermak's capsulotomy, 1204.
ectropion operation, 1430.
iridectomy in glaucoma, 1106.
operating mask, 219.
osteoplastic resection of orbital wall, 855.
sub-conjunctival cataract extraction, 1221, 1223.
symblepharon operation, 1461.
Czerny's osteoplastic frontal sinus operation, 1644.

D

Da Gama Pinto's after-cataract incision, 1329.
iris prolapse operation, 996.
Dacryops, surgical treatment of, 1608.
Damages at law, 51.
rules for estimating, 110.
Darier's brossage operation, 898.
forceps, 899, 900.
ptosis operation, 1541.
Davidson's method of localization, 337.
Daviel, Jacques, 27.
Daviel's cataract extraction, 1141.
incisions, 1150.
knives, 1148.
chalazion spoon, 484.
long curette, 928.
spoon, 484.
triangular corneal section, 1193.
de la Faye, de Wecker, etc.; see under Faye, Wecker, etc.
Dean's operation for nasal duct stricture, 1581.
pterygium operation, 873.
Deane's double suture of wounded eye, 777.
Death, condition of eye after, 124.
Decompression, 1692, 1701.
Dehenne's iridectomy in glaucoma, 1105.
Delafield, Edward, 38.
Demosthenes, 26.
Demours' cataract incision, 1150.
cataract knife, 1147, 1148.
Denig's capsulotome, 479.
Denker's maxillary sinus operation, 1659, 1660.
Dennett's electric ophthalmoscope, 303.
Denonvilliers' blepharoplasty, 1443.
ectropion operation, 1435.
Depression of lens, 1312.

Descartes, 26.
Descemet, 32.
Descemetocele, operation for, 772, 775.
DERBY, GEORGE S.: OPERATIVE TREATMENT OF EPIBULBAR TUMORS, 643.
Dermoid tumors, epibulbar, 645.
Dermolipoma, epibulbar, 645.
Deschamp's iridectomy in glaucoma, 1106.
Desmarres' cystotome, 1190.
  epicanthus operation, 1565.
  iridorhexis, 1056.
  lid clamp, 501, 502.
  lid retractor, 487.
  pterygium operation, 865, 874, 875.
Detacher for intracapsular cataract extraction, 1256, 1257.
Deutschmann's bisection knives for detached retina, 1378.
  lachrymal fistula operation, 1592.
  retinal detachment operations, 1375.
  syringe for intravitreous injections, 1377.
Dianoux's entropion operation, 1499.
  hydrophthalmus operation, 636.
  staphyloma operation, 589.
  trichiases operation, 1497.
Dickson's antrum trocar, 1649.
Dieffenbach, 37.
  and Kuhnt ectropion operations, combined, 1436, 1437.
  blepharoplasty, 1424, 1426.
  capsular excision, 743.
  ectropion operations, 1419, 1421, 1422, 1423.
  strabismus operation, 667.
Dietary of operator, 180.
Dietetics, post-operative, 282.
Dilator, 792.
  canaliculus and lachrymal duct, 481.
Dimmer's subconjunctival cataract extraction, 1222, 1224.
Dionin, 433.
Diplopia (crossed) test for simulated, 96.
Disc, choked, etiology of, 1685.
    operations for, 1682.
Discission, 797.
  complications of, 1296.
  in after-cataract, 1332.
  instruments for, 1295.
  knives, 477.
  of detached retina, 1361.
    posterior capsule in cataract extraction, 1218.
    vitreous membranes in retinal detachment, 1364.
  point of entrance in, 1328.
DISCISSION, RECLINATION AND MATURATION OF CATARACT, WITH SOME OTHER OPERATIONS ON THE CRYSTALLINE LENS; BY P. A. CALLAN, 1289.
Disease, Basedow's or Graves'; see Goiter, exophthalmic.
Diseases, exaggeration of, 108.
  false attribution of, 99.
  simulation of, 90.
Disinfection of operating rooms, 233.
  see also Antiseptics; Sterilization.
Dislaceration of detached retina, 1361.
Dissection, 183.
Dissector, blunt, 488.
Dissimulation of defects and disease, 109.
  of injury, 90.
Distichiasis, 1473.
Divergence, choice of operation for, 751.
Divulsor, 488.
Dix, John, 38.
Dix's keratoconus operation, 1009.
  spud, 486.
Dixon's cataract knife, 480.
  method of localization, 338.
Dodd's keratoconus operation, 968.
Donders, F. C., 40, 41.
Dor's cauterization for retinal detachment, 1374.
Dorell's nasal duct dilator, 483.
Douches, 413.
Drake-Brockman pterygium operation, 868.
Drain, frontal sinus, 1634.
Drainage tube, 1629.
Dransart's incision, 704.
  ptosis operation, 1524.
Dress, operating, 217.
Dressing forceps, 492.
  frequency of, 261.
  sterilizer, 535.
  tray, 261.
Dressings, 229.
  materials for 242.
  monocular or binocular, 252.
  post-operative, in cataract extraction, 1181.
  removal of, 261.
Duct, lachrymal; see Lachrymal duct.
Driver's muscle-shortening operation, 731.

E

Earning power as affected by injuries, 110.
East Indian methods of capsulo-lenticular extraction, 1259.
Echinococcus of orbit, operations for, 858.
Economics, visual, 110.
Ectropion, atonic, operations for, 1416.
  cicatricial, operations for, 1421.
ECTROPION, OPERATIONS FOR; BY C. H. BEARD, 1388.
  spastic mechanical operations for, 1409.
Egbert's trachoma curettes, 893.
Egypt, ophthalmology in, 18.
Eiselsberg's hypophysis operation, 1714.

ELECTRIC APPLIANCES IN OPHTHALMIC SURGERY; BY EDGAR S. THOMSON, 284.
cautery, 284.
in coneal ulcer, 934.
head mirrors, 308.
ophthalmoscope, 303.
Electrodes, galvano-cautery, 778.
Electrolysis, 291.
for epilation, 1486.
in nasal duct obstruction, 1597.
in retinal detachment, 1364, 1372.
Electro-magnets, 347.
in trachoma, 901, 905.
ELLETT, E. C.: AFTER-TREATMENT OF OPHTHALMIC OPERATIONS AND THEIR COMPLICATIONS, 235.
Ellett's anterior chamber irrigator, 415, 417, 511.
lachrymal syringe, 417, 511.
Elliot's glaucoma operation, 1118.
optic nerve hook, 487.
Elwood's irrigator, 508.
Elwood wash bottle, 758.
Elschnig's forceps, 202.
keratoconus operation, 971.
local anesthesia, 389.
ptosis operation, 1550.
Emanuel's lid holder, 504.
Emboitement, 973.
Embolism of retinal artery, 1384.
Emerson's double wire mask, 764.
Empyema of frontal sinus, 1623.
Encephalocele, surgery of, 844.
England, court systems in, 754.
malpractice in, 163.
ophthalmic expert testimony in, 72.
ophthalmo-sanitary laws in, 138.
Entropion, 1474.
forceps, 502, 503.
knife, 1518.
ENTROPION, ETC., OPERATIONS FOR RELIEF OF; BY W. H. WILDER, 1464.
operations for, 1499.
Enucleation of eye, 275, 549, 550, 554, 560, 638.
complications of, 275.
Enucleation forceps, 494.
ENUCLEATION OF THE EYE; BY F. ALLPORT, 539.
Enucleation, operations to relieve deformity following, 832.
Enucleation, post-operative treatment of, 562.
scissors, 498, 500.
spoons, 484, 485, 559.
thyroid; see Thyroid enucleation.
EPIBULBAR TUMORS, OPERATIVE TREATMENT OF; BY G. S. DERBY, 643.
Epicanthus, 1563.
EPICANTHUS, ETC., OPERATIONS FOR THE RELIEF OF; BY W. H. WILDER, 1464.
Epilation, electrolytic, 1486.
Epinon's massage for trachoma, 897.
Episcleral tissues, cauterization of for retinal detachment, 1374.
Epithelioma, epibulbar, 647.
Erwin's capsulotomy, 1210, 1211.
cataract knife, 477.
Escharotics, 451, 930.
Esophoria, choice of operation for, 751.
Esotropia, choice of operation for, 751.
Ethmoid cells, external operation on, 1672.
diseases, diagnosis of, 1666.
surgical treatment of, 1668.
instruments, 1169.
labyrinth, surgical anatomy of, 1665.
Ethmo-turbinal knives, 1670.
Ether, 378.
Ethyl bromid, 382.
Ethyl chlorid, 382.
Eucain, 404.
Eversbusch's ptosis operation, 1545.
Evisceration knife-spatula, 488, 489.
of eye, 575, 585, 589.
results of, 583.
orbital, 827.
operations to relieve deformity following, 832.
orbito-sinus, 834.
scoops, 484, 485, 588.
spoon, 484.
versus enucleation, 544.
Ewing's entropion forceps, 502.
operation, 1508.
Exaggeration, tests for, 108.
Examination, preoperative, 207.
Exenteration; see Evisceration.
Exophthalmic goiter, 1737.
Exophthalmos, danger of after tenotomy, 695.
pulsating, 1767, 1768.
arterial ligation in, 840.
Exophoria, choice of operation for, 751.
Exothyropexy, 1754, 1755.
Exotropia, choice of operation for, 751.
Exostoses, orbital, extirpation of, 850.
Expert testimony, 163.
ophthalmic, 60.
Expression forceps, 492, 494, 496, 891.
hook for cataract extraction, 1265.
in trachoma, 887.
Extraction hooks for cataract, 1269.
Extendo-contraction of rectus, 740.
Externus, tenotomy of, 687.
Extraction wound, suppuration of, 1237.
Eye, artificial, 457, 597, 639, 830.
burns of, 282.
condition of, after death, 124.
enucleation of, 275, 549, 550, 554, 560, 638.
EYE, ENUCLEATION OF; BY F. ALLPORT, 539.
evisceration of, 575, 585, 589.
foreign bodies in, 322, 781, 787, 795, 799.

Eye injuries of, exaggeration of, 108.
false attribution of, 99.
simulation of, 90.
lotions, 409.
shield, 418, 419, 763, 1182.

EYE SYMPTOMS, OPERATION ON DISTANT ORGANS FOR RELIEF OF; BY A. E. HALSTEAD, 1682.

Eye, vascular protrusion of; see Exophthalmos, pulsating.
wounded, asepsis of, 756.
conservation of, 755.
surgical toilet of, 280.
treatment of, 758, 761.
immediate, 756.
Eyeball, fixation of, 201, 745, 1165.
foreign bodies in posterior segment of, 800.
galvano-puncture of in retinal detachment, 1363.
localization of foreign bodies in, 322.
operations to change position of, 673, 742.
postoperative hemostases in, 238.
Eyebrows, signs of injuries of, 100.
Eye-cups, 413, 415.
Eye-dropper, 227.
Eye-drops, sterilization of, 226.
Eyelids, abscess of, 1568.
borders of, 1471.
treatment of, 1416, 1493.
burns of, 806.
Eyelids, cleansing of, 214, 760.
diseases of due to nasal disease, 1614.
foreign bodies in, 806.
injuries of, 280, 804.
signs of, 100.
management of, during ophthalmic operations, 197.
muscles of, 1467.
postoperative hemostases in, 236.
restoration of, 1441.
sterilization of, 214.
surgical anatomy of, 1389, 1465.
tumors of, operations on, 1572.

EYELIDS, TUMORS OF, REMOVAL OF; BY W. H. WILDER, 1464.

Eyestrain, tests for simulation, 91.
see also Lid.
wounds of, 280, 804.

F

Fabricius ab Aquapendente, 26.
Face masks, 217.
Fage's abscission, 582.
Falta's curettage in trachoma, 896.
pannus operation, 918.
roller forceps, 890.
suture, 914.
Favio's keratoconus operation, 963.
de la Faye's cataract knife, 1145, 1148.
Federal judicial system, 44.
Fees of expert witnesses, 70.
Fergus' glaucoma operation, 1118.
ptosis operation, 1541, 1553.
Ferguson's iridotomy scissors, 1344, 1345.
Ferrall, 38.
Ferrall's enucleation operation, 553, 556.
Fibroma, epibulbar, 644.
Filaria loa, operations for, 858.
Filtering cicatrix, 1108.
Filtration angle, transillumination of, 301.
Fire-arms, conjunctival injuries from, 768.
Fischer's iris forceps, 492.
Fischer-Arlt's iris forceps, 492.
Fisher's capsule forceps, 1213, 1270.
Fisher's lid elevator, 201, 791, 1272.
retractor, 487.

FISTULA AND ULCER CORNEAL, SURGICAL TREATMENT OF; BY H. B. CHANDLER, 923.

corneal, 938.
lachrymal, 1592.
Fixation forceps, 202, 492, 493, 494, 1026, 1116.
hooks, 486.
instruments, 1186.
of eyeball, 1166.
Flarer's keratoconus operation, 963.
trichiasis operation, 1487.
Flarer-Stellwag, trichiasis operation, 1488.
Flatulence after cataract extraction, 1245.
Fluid, postretinal, electrolysis of, in retinal separation, 1372.
subretinal, aspiration of, 1361.
Foggin's epicanthus operation, 1568.
Fontana, 32.
Forceps, 491.
advancement, 677.
capsule, 1213, 1270.
chalazion, 495, 496.
entropion, 502, 503.
fixation, 202, 492, 493, 494, 1026, 1116.
for extraction of ruptured capsule, 1265.
iris, 792, 1029, 1035, 1088, 1188.
lid, 503, 899, 900.
mosquito, 237.
nasal punch, 1625.
needle, 677.
roller, 887, 890.
scissors-handled, 494.
strabismus, 676, 677.
toothed, 945.
trachoma, 500.
turbinal, 1643.
see also Punch forceps.
Forceps-scissors, 490.
Forceps-spoon for cataract, 1225.
Foreign bodies in conjunctiva, 766.
cornea, 781.
crystalline lens, 799.

Foreign bodies in interior of eye, 802.
iris, 795.
lids, 806.
posterior segment of eyeball, 800.
sclerotic, 787.
injuries, 358.
operation for, 363.
instrument, 784.

FORENSIC RELATIONS OF OPHTHALMOLOGY; BY T. H. SHASTED, 43.

Förster's capsule forceps, 492.
maturation of cataract, 1317.
Fox's capsulotomy, 1209.
conformer, 600.
detacher, 1256, 1257.
divergent strabismus operation, 744, 745.
ectropion operation, 1415.
intracapsular cataract extraction, 1256.
method of localization, 327.
modification of Wales' operation, 592.
operation for delayed implantation, 614, 615, 616.
operating table, 537.
peridectomy, 918, 950.
pterygium operation, 877.
France, court systems in, 55.
malpractice in, 166.
ophthalmic expert testimony in, 72.
ophthalmology in, 32, 37.
ophthalmo-sanitary laws in, 139.
Francis' chalazion forceps, 495.

FRANK, MORTIMER: REPRESENTATIVE OPHTHALMOLOGISTS, 17.

Freezing mixtures, 400.
Freytag's cystotome, 1190.
Frick, George, 38.
Fricke's ectropion operation, 1440.
Froelich's corneal tattooing operation, 1003.
Fröhlich's glaucoma operation, 1129.
Frost's operation for implantation of glass ball, 610.
Frontal sinus chisels, 1634.
disease, treatment of, 1623.
drain, 1634.
instruments, 1632.
operations, intranasal, 1626.
osteoplastic operations on, 1644.
probes, 1630, 1633.
protectors, 1633.
rasps, 1634.
surgical anatomy of, 1618.
Frynin, 406.
Fuchs' tarsorrhaphy, 1398, 1400.
transfixio iridis for glaucoma, 1121.
wire cataract shield, 1182.
Fuchs' wire mask, 419, 763.
Furgeson's optic nerve scissors, 624.
optico-ciliary neurotomy, 623.
Furnari's pannus operation, 918.
Furnishings for operating rooms, 522, 536.
Furnishings for wards, 518.
Furuncle, 1568.

G

Gaillard-Arlt entropion suture, 1477, 1478.
Galen, 26.
Galezowski's cataract incision, 1151.
corneal section downward, 1193.
cystotome, 1191.
multiple retino-choroidal puncture for detached retina, 1373.
needle-holder, 499.
pterygium operation, 878.
sclero-choriotomy, 1129.
suturing of detached retina, 1366.
trachoma operation, 884, 908.
Galvano-cautery burner for keratoconus, 970.
electrodes, 778.
handle, 273.
in corneal ulcer, 934.
trachoma, 900.
points, 274.
Galvano-puncture, 955.
in ectropion, 1414.
retinal detachment, 1363.
Gama Pinto; see Da Gama Pinto.
Ganglion anesthesia, 389.
ciliary, removal of for glaucoma, 1133.
superior cervical, excision of in glaucoma, 1130.
Garengeot's cataract incision, 1150.
Gatch's anesthesia apparatus, 385, 386.
Gauze packer, 1630.
Gayet's iridectomy in glaucoma, 1106.
iridotomy, 1049.
keratokystitomie, 1208.
ptosis operation, 1526.
trichiasis operation, 1497, 1498.
Gelatine injections, 440.
Gelatine-serum injections in exophthalmus, 842.
Gèrard's magnetometer, 311.
Germany, court systems of, 57.
malpractice in, 166.
ophthalmic expert testimony in, 75.
ophthalmology in, 32, 37.
ophthalmo-sanitary legislation in, 141.
George's fixation forceps, 494.
Gibson, Benjamin, 37.
Gibson's cataract incision, 1150.
Gifford's ligation of ophthalmic vein in pulsating exophthalmus, 842.
lip-clamps, 503.
operation for sightless stumps, 635.
simple evisceration, 587.
Gillet de Grandmont's entropion suture, 1478.
ptosis operation, 1551, 1552.
Gioppi's intracapsular cataract extraction, 1253.
Giordano's hypophysis operation, 1714.

Gland, pituitary, thyroid; see Hypophysis, Thyroid.
Glasses, colored, 251.
Glaucoma after cataract extraction, 1242.
discission, 1296.
myopia operation, 1308.
congenital, 1076.
hemorrhagic, 1076.
treatment of, 1104.
GLAUCOMA, OPERATIVE TREATMENT OF; BY W. C. POSEY, 1064.
pathogenesis of, 1067.
secondary, 1071.
treatment of, 1104.
treatment of, 1076.
Gleize's discission of cataract, 1291.
Globe; see Eyeball.
Goggles, 418.
Goiter, exophthalmic, operations for, 1737.
Goldzieher's spastic entropion operation, 1483.
Golovine's operation for artificial eye, 831, 832.
optico-ciliary neurectomy, 625.
orbito-sinus exenteration, 834.
osteoplastic frontal sinus operation, 1644.
Good's frontal sinus operation, 1630, 1635.
Goyanes' eyelid restoration, 1450.
Gradenigo's intracapsular cataract extraction, 1258.
zonulotome, 1257.
v. Graefe, Albrecht, 28, 30, 39.
v. Graefe, C. F., 32.
v. Graefe, Edward, 33.
v. Graefe's capsulotomy, 1204.
cataract incision, 1150, 1151.
knife, 480, 1088, 1335.
cystotome, 475, 476, 1190.
discission of detached retina, 1361, 1364.
ectropion operation, 1424, 1425.
entropion operation, 1483, 1484.
iridectomy in glaucoma, 1086.
iridotomy, 1045.
knife, 1027, 1034, 1346.
method of holding, 1093.
modified, for cataract extraction, 1264.
keratoconus operation, 960, 1009.
lens retractor, 487.
spoon, 484.
squint hook, 486.
tarsorrhaphy, 1400.
test for simulated blindness, 95.
toothed forceps, 945.
Grafts, 1402.
Grandmont's entropion suture, 1478.
ptosis operation, 1551, 1552.
Granuloma, epibulbar, 644.
Grattage, 432, 892, 895.
Graves' disease, 1737.
Great Britain; see England.
Greeks, ophthalmology among, 20.
GREEN, JOHN, JR.: OPERATIONS AND OTHER SURGICAL TREATMENT FOR THE RELIEF AND CURE OF TRACHOMA, 881.
Green's entropion operation, 1506.
extirpation of conjunctival sac, 834.
styles, 485, 1594.
tendon-tucker, 510.
GREENE, D. W.: INTRACAPSULAR EXTRACTION OF CATARACT, 1247.
Greene's cataract-in-capsule-toilet, 1286.
intracapsular cataract extraction, 1271.
modification of Knapp's iris repositor, 1271.
Smith's spatula, 1272.
tendon-folding instrument and operation, 728, 729.
Greenwood's intraocular irrigation, 511, 1217, 1218.
Griffin's suction curette, 501.
Grimsdale's ptosis operation, 1536.
tendon-lengthening incision, 704.
Gronbähn's suture, 914.
Grossman's method of localization, 327.
Greven's lid speculum, 505.
Gruening's magnet, 349.
ptosis operation, 1552.
Guaiac, oil of, 406.
Guerin's advancement operation, 672.
strabismus operation, 670.
GUILFORD, PAUL: INSTRUMENTS USED IN OPHTHALMIC SURGERY, 469.
Guilloz' method of localization, 346.
Guthrie, George, 37.
Guthrie's keratotomy, 779, 957.

H

Haab's magnet, 350.
Haberkamp's method of galvano-puncture, 955.
Haile's illuminator attachment for the ophthalmoscope, 516.
Hair, removal of by electrolysis, 292.
Hajek's ethmoid operation, 1672.
knife, 1669.
maxillary sinus operation, 1657.
modified Killian frontal sinus operation, 1640.
sphenoid punch, 1680.
Hajek-Luc on frontal sinus operation, 1634, 1636.
Hall's enucleation with sclero-optic neurectomy, 626.
Halle's frontal sinus operation, 1630.
HALSTEAD, A. E.: OPERATIONS ON DISTANT ORGANS FOR THE RELIEF OF EYE SYMPTOMS, 1682.
Halstead's exophthalmic goiter operation, 1743.
hypophysis operation, 1717.
method of controlling scalp hemorrhage, 1693.

Halstead's mosquito forceps, 237, 495.
Hammurabi, code of, 170.
Hancock's expression forceps, 891.
  glaucoma operation, 1122.
Hands of operator, sterilization of, 219.
HANSELL, HOWARD F., AND BELL, JAMES HALL: OPERATIONS ON THE LACHRYMAL APPARATUS, 1574.
Hansell and Sweet's method of enucleation, 570.
Harlan's ectropion operation, 1428, 1429.
  symblepharon operation, 1459.
  test for simulated blindness, 96.
Harman's ptosis operation, 1530.
  retractor, 506.
Harris' operation for nasal duct obstruction, 1598.
Hasner's blepharoplasty, 1444, 1446.
Hays, Isaac, 38.
Hays' cystotome, 477.
  enucleation spoon, 486.
  knife-needle, 1326.
Head mirrors, electric, 308.
Headlight, electric, 1658.
Heat, applications of, 265, 427.
Hebra's chalazion spoon, 484.
Heine's cyclodialysis, 1123.
Heisrath's trachoma operation, 909.
Heister's pterygium operation, 864.
Helbra's curette, 928.
Helmbold's ectropion operation, 1438.
Helmholtz, Hermann von, 38, 39.
Hemangioma, epibulbar, 644.
Hemophilia, 239.
Hemorrhage, arrest of, 203, 236, 675.
  arterial ligation in, 840.
  during excision of lachrymal sac, 1605.
  expulsive, after cataract extraction, 1234.
  following after-cataract operations, 1347.
  from scalp, method of controlling, 1693.
  into the anterior chamber in cataract extraction, 1229.
Hemostasis, 203, 236.
  in strabismus operations, 675.
Hemostatic forceps, 495.
Herbert's hypopyon procedure, 960.
  incarceration operation in glaucoma, 1113.
  wedge-isolation method in glaucoma, 1114.
Herczogh's massage for trachoma, 897.
Hern's operation for glaucoma, 1086.
Herrnheiser's lid forceps, 495.
Hertzell's opthalmo-diaphanoscope, 308.
Hess' ptosis operation, 1532.
Hess' spoon, 484.
Heteroplasty, 1446.
Heuermann's iridotomy, 1045.
Heurteloupe's artificial leech, 510.
Heustis' method of removing powder stains, 806.
Heyl's discission needle, 478.
Higgins' intracapsular cataract extraction, 1256.
Highmore, antrum of; see Maxillary sinus.
Himly, Carl, 32, 38.
Himly's iris hook, 486.
  symblepharon operation, 1457.
v. Hippel's corneal trephine, 1022.
  keratoconus operation, 1022.
Hippocrates, 18.
Hirschberg's electro-magnet, 348.
  sideroscope, 311.
Hobby's pterygium operation, 872.
Hochenegg's hypophysis operation, 1716.
v. Hoffmann's canaliculus operation, 1582.
Holocain, 397, 403.
Holth's corneal trephine, 1004.
  cystoid cicatrix in glaucoma, 116.
  double blunt hook for turning back conjunctiva, 1116.
  elbowed fixation forceps, 1116.
  method of localization, 328.
  modification of Vacher's punch-forceps, 1116.
  sclerectomy for glaucoma, 1117.
Hook neurotome, 559, 560, 625.
Hooks, 486.
  blunt double, for turning back conjunctiva, 1117.
  ethmoidal, 1669.
  expression, for cataract extraction, 1265.
  extraction, for cataract, 1263, 1269.
  iris, 1088.
  lid, 792, 901.
    for cataract extraction, 1265, 1272.
  strabismus, 670, 671, 677, 678, 727.
Hordeolum, surgical treatment of, 1569.
Horner's cataract incision, 1153.
Hospital stretchers for ophthalmic patients, 527.
HOSPITAL WARDS AND ROOMS; BY T. A. WOODRUFF, 513.
Hospitals, private ophthalmic, 524.
Hot applications, 265, 427.
Hotz's ectropion operation, 1432.
  entropion operation, 1503.
  restoration of cul-de-sac, 1462.
  trachoma operation, 884.
  trichiasis operation, 1503.
Howard's cataract knife, 1152, 1155.
Howe's advancement operation, 714.
    suture, 715.
  fixation forceps, 493.
  hemostatic forceps, 495.
  muscle clamp, 678.
Hubbell's magnet, 349.
Huizinga's eviscero-neurotomy, 627, 630, 631, 632.

Hulen's advancement suture, 712.
method of localization, 338.
Hummelsheim's operation for paralysis of external rectus, 740.
Hunt's chalazion forceps, 496.
ptosis operation, 1524.
Hydrodictyotomy, 1362.
Hydrophthalmia, conical; see cornea, conical.
Hydrophthalmus, operation for, 636.
Hydrotherapy, 454.
Hyperemia, treatment, 454.
Hyperkeratosis; see cornea, conical.
Hypopyon ulcer, 939.
operation for, 779, 959.
Hyperthyroidism, 1737.
Hypothetical questions, 68.
Hypophysis, operations on, 1710.

I

Identity, ocular signs of, 130.
Illumination in cataract extraction, 1164.
Illumination of wards and rooms, 519.
Illuminators; see Lamps.
Implantation, delayed, operation for, 614.
Incarceration methods in glaucoma, 1113.
Incisions, after-cataract, 1328, 1330.
cataract, 1150, 1151, 1153, 1167, 1178, 1193, 1229, 1274, 1279.
delayed union of margins of, 1233.
in orbital operations, 820.
Indian methods of capsulo-lenticular extraction, 1259.
pedunculated flaps, 1440.
Indigestion after cataract extraction, 1245.
Infratrochlear nerve, avulsion of for glaucoma, 1154.
Infection, cauterization for, 289.
postoperative, 270.
Inferior oblique, tenotomy of, 702.
rectus, tenotomy of, 691.
Infiltration anesthesia, 395.
Ingals' gauze packer and medication bulb, 1630.
frontal sinus operation, 1627, 1631.
probes, 1630.
Inhalation anesthesia, 377.
Injections, gelatine, 440.
gelatine-serum, 842.
intraocular, instruments for, 1370.
intravenous, 443.
paraffin, 440.
subconjunctival, 435.
for detached retina, 1366.
in trachoma, 916.
Injuries, exaggeration of, 108.
false attribution of, 99.
foreign body, 358.
magnet operation for, 363.
simulation of, 90.
surgical toilet of, 280.

INJURIES TO THE VISUAL APPARATUS, SURGICAL TREATMENT OF; BY H. V. WUERDEMANN, 755.

Inouye's cataract knife, 480.
Instrument handles, 471.
sterilizers, 533.
Instruments, classification of, 471.
correct manner of holding, 189, 190, 191.
after-cataract, 1325.
cataract, 1185, 1263, 1265, 1269, 1272.
couching, 1313.
discission, 1295.
ethmoid, 1669.
frontal sinus, 1632.
iridectomy, 1088.
strabismus, 676.
preparation of, 230.
sphenoid, 1677.
tests for sharpness of, 232, 512, 1185.

INSTRUMENTS USED IN OPHTHALMIC SURGERY; BY PAUL GUILFORD, 469.

see also names of instruments.
Internus, tenotomy of, 682.
Intracapsular operation, instruments for, 1269, 1272.
Intracranial operation, dangers and complications of, 1720.
Intracutaneous anesthesia, 400.
Intraocular disease due to nasal and sinus disease, 1616.
injection, instruments for, 1370.
irrigation during cataract extraction, 1215.
medication, 445.
tumors; see Tumors, intraocular.
Intravenous injections, 443.
Iodine, intraocular injections of in retinal detachment, 1369.
Iricystome, Culbertson's, 479.
Iridectomy, 28, 31.
complications of, 278.
in cataract extraction, 1174.
corneal staphyloma, 983.
detachment of retina, 1362.
glaucoma, 1086, 1117.
accidents complicating, 1096.
after-treatment of, 1098.
complications of during healing, 1099.
prognosis after, 1100.
intracapsular cataract extraction, 1276, 1281.
retinal embolism, 1386.
instruments for, 1088.

IRIDECTOMY, IRIDOTOMY AND SOME ALLIED OPERATIONS; BY A. ALT, 1024.

knife, 868.
modifications of, 1105.
preliminary to cataract extraction, 1199.
Iridenkleisis, 1056.
anti-glaucomatosa, 1116.

Iridic synechiæ, operations for, 1058.
Irido-cyclitis after glaucoma, 1099.
post-operative, 273, 1236.
Iridocystectomy for after-cataract, 1340.
Iridodesis, 965, 1009, 1056.
Iridodialysis, 1055.
during iridectomy, 1040.
traumatic, 795.
iridenkleisis in, 1057.
Iridoectomy, 1053.
Iridolysis, 1058.
anterior, 1060.
posterior, 1059.
Iridorrhexis, 1056.
Irido-sclerotomy in glaucoma, 1109, 1082.
Iridotomes; see Iris knives.
Iridotomy, 1044.
double, 1047.
for after-cataract, 1341.
complicated after-cataract, 1339.
history of 1044.
knives; see Iris knives.
scissors, 1343, 1344, 1345.
with cataract extraction, 1200.
Iris angle, incision of, for glaucoma, 1084.
buttonholing of, in cataract extraction, 1230.
fallen in front of knife, management of, 1227.
forceps, 492, 494, 792, 1029, 1035, 1088, 1188.
foreign bodies in, 795.
hooks, 486, 1088.
incarceration of in cataract operation wound, 1239.
knife, 1027, 1028, 1032, 1033, 1034, 1035, 1052, 1327, 1346.
prolapse, 771, 790.
excision of, 985.
in cataract extraction, 1231.
prevention of, 1232.
sequelæ of, 1240.
punch, 1054.
reposition of in Smith operation, 1268.
repositor for intracapsular operation, 1270, 1271.
scalpel for after-cataract, 1339.
scissors, 490, 497, 498, 500, 1030, 1088, 1188.
separation of during iridectomy, 1096.
signs of injuries of, 107.
spatula, 1189.
stabbing of, in cataract extraction, 1228.
synechiæ of, 1072.
transfixion during iridectomy, 1096.
transfixion for glaucoma, 1121.
transillumination of, 301.
tumors of, 1043.
Iritis, after-cataract extraction, 1235.
discission, 1297.
iridectomy, 1099.
Iritis, after myopia operation, 1308.
due to nasal disease, 1616.
iridectomy in the sequelæ of, 1042.
postoperative, 273.
Iritomy, peripheral, 1085.
in cataract operation, 1202.
Irrigating apparatus and cannulæ, nasal, 1624.
fluids, 413.
Irrigation, 263, 410.
intraocular, during cataract extraction, 1215.
Irrigators, 214, 215, 263, 264, 265, 266, 413, 507, 508, 511.
anterior chamber, 781, 1189, 1319.
for ophthalmic operating room, 534.
Irrigators; see also Syringes.
Italian heteroplasty, 1446.
Italy, court systems of, 59.
malpractice in, 168.
ophthalmic expert testimony in, 77.
ophthalmo-sanitary legislation in, 144.

J

Jackson, Edward: Operations on the extrinsic or orbital muscles, 649.
Jackson's advancement with single scleral stitch, 707.
cataract knife, 480, 1188.
corneal knife, 1187.
tenotomy of superior oblique, 703.
test for simulated blindness, 97.
Jacobson's cataract incision, 1150.
Jaeger, Friedrich, 33.
Jaeger's cystotome, 1191.
ectropion operation, 1424.
iris hook, 486.
lid holder, 509.
Jaesche-Arlt trichiasis operation, 1489.
Jameson's method of replacing iris fallen in front of knife, 1227, 1228.
operation for iris prolapse, 794.
traumatic iridodialysis, 1058, 1059.
trachoma files, 488.
trachomatome, 894.
Janin's cataract incision, 1150.
Jansen's frontal sinus operation, 1637.
Janson's entropion operation, 1482.
Janssen's siderophone, 313.
Jessop's advancement operation, 706.
Jobson's iridotomy, 1057.
knife-needle, 477.
Johnson's magnet, 352.
Jones' ectropion operation, 1423, 1424.
modified Liebreich's eye-dropper, 227.
Jonnesco's glaucoma operation, 1131.
Joseph's hook-neurotome, 559, 560, 625.
Jullundur cataract extraction, 1261.
corneal section, 1275.
toilet of wound, 1284.

Juries, 47.
Jurisdiction of courts in U. S., 45.

K

Kalt's corneal suture, 1220, 1222.
Kanavel's hypophysis operation, 1716.
Kauffmann's apparatus for massage of the eyeball, 455, 456.
Kepler, 26.
Keratectomy (abscission) 575, 577.
Keratitis, post-operative, 273, 1238.
Keratocele, 772, 775, 938.
Keratoconus; see Cornea, conical.
Keratokystitomie in cataract extraction, 1208.
Keratome, method of holding, 1090.
Keratomes, 474, 476, 1047, 1187.
Keratonyxis; see Cataract, discission of.
Keratoplasty, 769, 776, 1013.

KERATOPLASTY; OPERATIONS FOR CONICAL CORNEA; BY W. O. NANCE, 1006.

Keratotomy, 779, 957, 961.

KERATOTOMY AND OTHER OPERATIONS ON THE CORNEA; BY C. A. OLIVER, 942.

Kerotomy, 955.
Killian's frontal sinus operation, 1637.
Kiliani's hypophysis operation, 1711.
Kipp's chalazion forceps, 495.
Klaar's electric headlight, 1658.
Klaar-Alexander mirror, 308.
Kirkendall's lachrymal syringe, 510.
Knapp's capsulotomy, 1204, 1205.
  cautery points for keratoconus, 1012.
  cystotome, 475, 476, 1191.
  ectropion operation, 1433.
  epicanthus operation, 1564.
  expression or roller forceps, 494.
  frontal sinus operation, 1642.
  galvano-cautery electrodes, 778.
  hook for extracting foreign bodies, 487.
  iridocystectomy, 1340.
  iris repositor, modified, 1271.
  keratoconus operation, 970.
  knife-needles, 477, 1327.
  lid clamp, 502.
  method of abscission, 579.
  method of enucleation, 572.
  needle-holder, 499.
  optico-ciliary neurectomy, 620.
  operation for dislocated lens, 1311.
  probe, 482.
  pterygium operation, 875, 876.
  roller forceps, 887.
  spoon, 484.
  staphyloma operation, 980.
  tendino-capsular advancement, 722.
  trachoma forceps, 500.
Knies glaucoma operation, 1083, 1112.
Knife-needles, 477, 1333.
  and spud, electric, 308.
Knife-needles for after-cataract, 1326, 1327, 1328, 1329, 1332.
Knife-sterilizer, 526, 527.
Knives, bisection, for detached retina, 1378.
  canaliculus, 1582.
  cataract, 477, 479, 1078, 1088, 1144, 1152, 1154, 1155, 1187, 1188, 1195, 1264, 1271, 1326, 1327, 1328, 1329, 1333.
  corneal, 474, 476, 1047, 1090, 1187.
  discission, 478.
  entropion, 1518.
  ethmoidal, 1669.
  ethmo-turbinal, 1670.
  iris, 477, 478, 1027, 1028, 1032, 1033, 1034, 1035, 1052, 1346.
  lachrymal, 474, 475, 1582.
  pterygium, 20, 21, 474, 867, 868.
  sinus, 1626.
  sphenoid, 1677.
  testing of, 232, 512, 1185.
  trachoma, 904.
Kocher's angular incision in unilateral resection of the thyroid, 1747.
  collar incision in strumectomy, 1744.
  resection-enucleation of the thyroid, 1753.
Koenig's hypophysis operation, 1713.
Kopiopia, tests for simulation of, 91.
Korn's cautery for trachoma, 901.
Köster's fixation forceps, 493.
Koster's styles, 1596.
Koyle's descemetocele operation, 775.
Krause's flexible subdural sound, 1699.
  hypophysis operation, 1711.
  nasal snare, 1627.
Krönlein's operation, 851.
Krusius' styles, 1597.
Küchler's cataract incision, 1151.
  staphyloma operation, 976.
Kuhnt and Dieffenbach ectropion operations, combined, 1436, 1437.
Kuhnt's after-cataract operation, 1340.
  conjunctivoplasty, 769, 770, 771, 992, 993.
  ectropion operation, 1417, 1418, 1419.
  epicanthus operation, 1564.
  expressor, 492, 891.
  frontal sinus operation, 1635.
  keratoplasty, 776.
  trachoma operation, 884.
Kuhnt-Szymanowski ectropion operation, 1427.
Küster's maxillary sinus operation, 1656.

L

Labor, induction of, for detached retina, 1373.
Lachrymal apparatus, diseases of, due to diseases of neighboring cavities, 1615.
  injuries to, 808.

LACHRYMAL APPARATUS, OPERATIONS ON; BY H. F. HANSELL AND J. H. BELL, 1574.
surgical anatomy of, 1574.
fistula, 1592.
dilators, 481.
gland, extirpation of, 1606.
knives, 474, 475, 1582.
operations, 1578, 1597.
passages, cleansing of, 760.
probes, 481, 1585, 1589.
retractors, 506.
sac clamp, 509.
excision of, 279, 1598.
incision of, 1591.
obliteration of, 1604.
postoperative hemastasis in, 236.
retractors, 509.
stricture, electrolysis for, 294.
styles, 484.
syringe, 1591.
syringes, 417, 505, 509, 1592.
Lack's knife, 1626.
Lagleyze's ectropion operation, 1434.
entropion operation, 1510.
muscle-shortening, 723.
Lagrange and Aubaret's intraocular irrigation during cataract extraction, 1216, 1217.
Lagrange's blepharoplasty, 1449.
eyeball transplantation, 633.
irido-sclerotomy in glaucoma, 1109.
method of abscission, 578, 579, 580, 585.
operation for delayed implantation, 617, 618, 619.
optic nerve tumor, 824.
Lamp and transilluminator, 782.
electric, for after-cataract operation, 1331.
for operating room, 524.
for ward use, 520, 521, 522.
Lance knives; see Knives.
Lancereaux-Paulesco treatment of pulsating exophthalmus, 842.
Lancet for couching, 1313.
Landesberg's intracapsular cataract extraction, 1254.
Landman's method of forming the stump after Mules' operation, 608.
Landolt's advancement operation, 709.
blepharoplasty, 1445, 1447.
blepharostat, 1026.
cystotome, 477, 1191.
keratome, 476.
lid speculum, 504.
ptosis operation, 1533.
tendon-lengthening operation, 703.
trichiasis operation, 1492.
Lang's iridolysis, 1061.
operation for detached retina, 1382.
implantation of glass ball, 610.
Lange's lid speculum, 504.
spoon, 484.
transilluminator, 297.
Langenbeck's cystotome, 1190.
needle-holder, 499.
Lapersonne's method of evisceration, 588.
ptosis operation, 1549.
Lasiner, Rémy, 26.
Lathrop's frontal sinus operation, 608.
Lauber's method of forming the stump after Mules' operation, 608.
Law in England, 54.
France, 55.
Germany, 57.
Italy, 59.
U. S., 44.
Lawford's speculum, 215.
Lawrence, Sir William, 37.
Lea's advancement stitch, 720, 721.
Leber's transilluminator, 296.
Lebrun and Warlomont's cataract incision, 1151.
Lebrun's cataract incision, 1154.
Leeches (including artificial), 267, 446, 510, 764, 765.
Lefever's anesthesia mask, 379.
LEGAL RELATIONS OF OPHTHALMOLOGY; BY T. S. SHASTED, 43.
Legislation, ophthalmo-sanitary, 132.
Leiter's coil for hot or cold applications, 267.
Lens capsule; see Capsule.
cataractous, dislocation of, 1231.
expression of, 1282.
couching of, 1312.
LENS, CRYSTALLINE, VARIOUS OPERATIONS ON; BY P. A. CALLAN, 1289.
delivery, 1175, 1214, 1277, 1278, 1282.
instruments for, 1189.
Lens, dislocated, 1312.
operations for, 1309.
foreign bodies in, 799.
injuries of, 1073.
signs of, 107.
treatment of, 796.
instrumental rotation of in cataract extraction, 1214.
luxation, 1073.
during iridectomy, 1097.
needle, 501.
needling or discission of, 1289.
retractor, 487.
transillumination of, 301.
wounds of, 107, 796, 1073.
Leucoma, corneal, tattooing of, 996.
Levis' fenestrated loop, 485.
Levinsohn's tendon-folding instrument, 730, 731.
operation, 730.
Lewis' lachrymal sac clamp, 509.
tenotomy scissors, 500.
Lid clamps and holders, 238, 501, 509.
elevators and retractors, 201, 487, 488, 489, 791, 792, 1272, 1313.
forceps, 495.
hooks, 1263, 1265, 1272.

Lid specula, 503.
Lid; see also Eyelids.
Liebold's iris forceps, 492.
scissors, 497.
Liebreich, 38.
Liebreich's cataract incision, 1153, 1154.
eye-dropper, Jones' modification of, 227.
rotary iris forceps, 492.
Liekernik's massage for trachoma, 896.
Ligaments, check, 663.
division of, 742.
Light for cataract extraction, 1164.
Light; see also Headlight.
Lighting of wards and rooms, 519.
Lipoma, epibulbar, 645.
Lippincott's irrigator, 507, 511, 781.
magnet, 352.
Lipscomb's pterygium operation, 873, 874.
Lisfranc's total tarsorrhaphy, 1402.
Localization methods, X-ray, 326.
Loewe's hypophysis operation, 1713.
Logetschnikow's sclero-dilatatorectomy in glaucoma, 1108.
Loops, 485, 486.
Lotions for the eye, 409.
Loup, binocular, 783.
Luc-Caldwell maxillary sinus operation, 1657.
de Lucé's cataract incision, 1151.
Luedde's operation for lachrymal fistula, 1592.
Luer's needle-holder, 499.
Lucca's intracapsular cataract extraction, 1250.
Lumbar puncture, diagram of, 1734.
Lymphagogues, 433.
Lymphangioma, 1572.
epibulbar, 644.
Lymphoma, epibulbar, 644.

M

Mackenzie, William, 35.
Mackenzie-Davidson's method of localization, 337.
Mackenzie's iridotomy, 1045.
MacWhinnie's artificial leech, 765.
Maddox's conjunctival suture, 774, 1219.
Magnani's tendon-folding operation, 725.
Magnetometer, 311.
Magnet operation, 363.
results of, 373.
Magnets, 347.
comparison of, 356.
selection of, 362.
Maher's iridectomy for glaucoma, 1117.
Maître-Jean, Antoine, 26.
Malpractice, legal aspects of, 146.
surgical aspects of, 170.
Margino-plasty, 1497, 1500.
Mariotte, 26.
Marple's electric opthalmoscope, 304, 305.
Martin's anterior sclerotomy for glaucoma, 1081.
trachoma operation, 889.
Maser's operation for detached retina, 1382.
Masks after cataract extraction, 1182.
anesthesia, 379.
for practice operations, 184.
surgeon, 217.
ocular, 418.
papier-maché, 764.
wire, 252, 253, 254, 419, 763, 764.
Masks; see also Shields.
Massage apparatus, Kauffmann's, 455, 456.
in trachoma, 896.
of lids and eyeball, 429.
Masselon's equatorial sclerotomy, 1128.
Masseur, corneal, 432.
Mathieu iris forceps, 1035.
Maturation of cataract; by P. A. Callan, 1289.
Maturation of cataract, 1315.
Maunoir's iridotomy, 1045.
scissors, 1343.
Maxwell's tendon-folding with triple hook, 727.
Maxillary sinus disease, treatment of, 1650.
infections, diagnosis of, 1647.
operations, 1650, 1656.
after-treatment of, 1662.
surgical anatomy of, 1645.
Mayer's cataract knife, 1147.
May's eyeball transplantations, 632.
operating table, 537.
Mayo's incision for ligation of superior thyroid arteries, 1756.
Mayou's ptosis operation, 1553.
X-ray treatment of trachoma, 906.
Mayweg's magnet, 352.
McClure's iris forceps-scissors, 490.
McConachie's operation for nasal duct stricture, 1581.
McGillivray's incision in after-cataract, 1330.
McKeown's irrigator, 507.
McReynolds' pterygium operation, 875, 877.
Medication bulb, 1630.
intraocular, 445.
Medicine droppers, 410.
Meibomian infarcts, removal of, 1571.
Mellinger-Beard's lid speculum, 504.
Mellinger's eye speculum, 200, 504.
magnet, 354.
Menacho's optico-ciliary neurotomy, 626.
de Mendoza's corneal suture, 1221.
Mental disturbances after senile cataract extraction, 1246.
Méry, 38.

Meyer's cystotome, 1191.
enucleation operation, 573.
iridolysis, 1061.
keratoconus needle, 966, 967.
operation for detached retina, 1362.
Meyhoefer's chalazion spoon, 484.
Michel's passive motion, 742.
Microscope, corneal, 517.
Mikulicz' maxillary sinus operation, 1652.
Middle Ages, opthalmology in, 23.
Middlemore's keratoconus operation, 1008.
staphyloma operation, 979.
Miller's anesthesia apparatus, 379.
Millette's modification of Smith's lid hook, 1272.
Miotics in glaucoma, 1102.
Monosmith's enucleation operation, 573.
Monoyer's cataract incision, 1151.
Montgomery's entropion suture, 1479.
Moorfield's bandage, 420.
Ophthalmic Hospital, foundation of, 37.
Moraweck's lid elevator, 489.
Morax's autoplasty, 1437, 1438, 1439.
Morenheim's intracapsular cataract extraction, 1249.
Moretti's operation for lachrymal fistula, 1592.
Morton's keratoconus operation, 969.
operation for implantation of glass ball, 610.
Mosetig's technic after orbital exenteration, 846.
Moskowicz and Tandler's hypophysis operation, 1714.
Mosquito forceps, 237, 495.
Motais' posterior sclerotomy, 1127.
ptosis operation, 1557.
Motion, passive, of eyeball, 742.
Moulton's styles, 1594.
Mucous anesthesia, 400.
Mueller's ectropion operation, 1418.
operation for detached retina, 1380.
Mules' enucleation scissors, 500.
evisceration operation, 500.
ptosis operation, 1527.
repositor, 510.
Müller's capsule forceps, 494.
corneal incision, 1194.
ectropion operation, 1420.
lachrymal sac retractor, 509.
muscle-shortening operation, 733.
Mulroney's intracapsular cataract extraction, 1259.
Murdoch's lid speculum, 503.
tenotome, 501.
Muscle clamp, 678.
Muscles, ocular, injuries to, 809.
operations to change functions of, 737.
orbital, anatomy and physiology of, 650.
dimensions of, 658.
functions of, 653.
Muscles, orbital or extrinsic, operations on; by E. Jackson, 649.
palpebral, 1392.
superciliary, 1390.
Muscles; see also names of muscles.
Muscle-shortening with section or resection, 731.
Mutermilch's entropion operation, 1500.
Myers' peripheral iritomy, 1202.
Myopia, complications of operation for, 1308.
operative treatment of high degrees of, 1300.
Myopic astigmatism, operations for, 467.
Myotomy for strabismus, 667.
Myles' antrum trocar, 1649.
maxillary sinus operation, 1651.
nasal punch forceps, 1628.

N

Nance, Willis O.: Operations for conical cornea—keroplasty, 1006.
Nasal disease causing diseases of eyelids and conjunctiva, 1614.
duct, self-probing of, 1587.
irrigating apparatus and cannulæ, 1624.
punch forceps, 1625, 1628.
scissors, 1625.
snare, 1627.
tampon, 1628.
Naso-lachrymal duct, syringe for, 1591.
duct, obstruction, operations for, 1592.
knives, 1582.
probes, 1585.
see also Lachrymal.
Nebinger-Praun's frontal sinus operation, 1633.
Nebulizers, 416.
Needle and spud, combined, for removal of foreign bodies from cornea, 944.
Needles, couching, 1313.
discission, 477, 478.
forceps, 677.
for removal of lens, 501.
keratoconus, 967.
tattooing, 478, 479, 1002.
Needle-holders, 499, 500.
Needling of lens, 1289.
Necrosis of orbit, operations for, 846.
Nerve, infratrochlear, optic, etc.; see infratrochlear nerve, optic nerve, etc.
Nettleship's probe, 482.
test for simulated blindness, 97.
Neurectomy, optico-ciliary, 616.
Neuritis, optic, etiology of, 1685.
operations for, 1682.
Neurotome, 559, 560, 625.
Neurotomy, optico-ciliary, 616, 620.
Nevus, epibulbar, 645.
Nicati's enucleation operation, 629.

Nicati's iridotomy, 794.
ptosis operation, 1551.
scleriritomy, 1083.
trichiasis operation, 1496.
Nirvanin, 399:
Nitrous oxid in ophthalmic operations, 383.

NOSE AND ITS ACCESSORY SINUSES, OPERATIONS ON FOR THE RELIEF OF OCULAR SYMPTOMS; BY F. BRAWLEY, 1610.

surgical relations of to ocular structures, 1610.
Notta's cataract incision, 1151.
Novocain, 405, 423.
infiltration anestheisa, 397.
Noyes' advancement stitch, 721.
cataract knife, 480.
expression forceps, 496.
eye speculum, 505.
fixation forceps, 493.
lid forceps, 503.
retractor, 488.
muscle-shortening operation, 731, 753.
scissors, 497, 1344, 1345.
toothed loop, 485.
Nuel's suture for scleral rupture, 789, 790.
Nurses' operating dress, 221.
Nurses, ophthalmic, 529.

O

Oblique muscles, tenotomy of, 702.
superior, grafting of tendon of, 741.
use of superior rectus to correct paresis of, 737.

OCULAR INJURIES, SURGICAL TREATMENT OF; BY H. V. WUERDEMANN, 755.

muscles, injuries to, 809.
protheses; see Eye, artificial, 457.
Oculo-motor paralysis, transplantations for, 741.
Oculo-muscular disturbances due to sinus disease, 1615.
Ogston-Luc frontal sinus operation, 1634, 1636.
O'Kunueff's operation for lachrymal fistula, 1592.

OLIVER, CHARLES A.: PARACENTESIS, KERATOTOMY, CONJUNCTIVOPLASTY AND SOME OTHER OPERATIONS ON THE CORNEA, 942.

Oliver's advancement suture, 720.
operation for implantation of glass eye, 612, 613.
Ollier's grafts, 1407.
O'Meara's keratoplasty, 1020.
Operating costume, 217.
rooms and furnishings, 522, 536.
preparation of, 233.
tables, 189, 537, 1694.

OPERATIONS, ANESTHESIA IN; BY WENDELL REBER, 377.

assistant's duties at, 195.

OPERATIONS FOR ENUCLEATION OF THE EYE AND THEIR SUBSTITUTES; BY FRANK ALLPORT, 539.

general management of, 224.
in an amphitheater, 531.
major, wards for, 521.

OPERATIONS, OPHTHALMIC, AND THEIR COMPLICATIONS, AFTER-TREATMENT OF; BY E. C. ELLETT, 235.

posture during, 188.

OPERATIONS, PREPARATION FOR; BY W. G. M. BYERS, 205.

of field of, 212.
treatment after; see Post-operative treatment.
visitors and assistants at, 193, 226.
Operations, see also names of operations and conditions.

OPERATIVE SKILL, DEVELOPMENT OF IN SURGEON; BY ALBERT E. BULSON, 179.

work, time of day for, 182.
wound, infection of, 1236.
Operator, personal habits and qualifications of, 180.
position of in cataract operation, 1165.
preparation of, 216.
Ophthalmia, sympathetic, after enucleation, 545, 546.
Ophthalmic expert testimony, 60.

OPHTHALMIC HOSPITALS; BY THOMAS A. WOODRUFF, 513.

private, 524.
nurse, 529.
operating rooms, 536.
tables, 537.
pipettes, 410.

OPHTHALMIC SURGERY, INSTRUMENTS USED IN; BY PAUL GUILFORD, 469.

OPHTHALMIC SURGERY, MINOR REMEDIES EMPLOYED IN; BY CASEY A. WOOD, 408.

wards, 513, 517.
in general hospitals, 528.
Ophthalmo-diaphanoscope, 308.

OPHTHALMOLOGISTS, REPRESENTATIVE; BY M. FRANK, 17.

OPHTHALMOLOGY, LEGAL RELATIONS OF; BY T. S. SHASTED, 43.

Ophthalmometer, invention of, 39.
Ophthalmoscope, electric, 303, 522.
illuminator attachment for, 516.
invention of, 38.
Ophthalmotomy, posterior, 1358.
Optic nerve disease, due to sinus disease, 1616.
speculum, 507.

Optic nerve tumors, extirpation of, 824.
wounds of, 804.
Optic neuritis; see Neuritis, optic.
Optico-ciliary neurotomy, 615, 616, 621.
Orbicularis, fibers of, correction of spastic conditions of, 1475, 1476.
Orbit, abcess of, 821.
cicatricial, operation for, 1463.
check ligaments of, 663.
evisceration or exenteration of, 827.
localization of foreign bodies in, 322.
ORBIT, OPERATIONS ON MUSCLES OF; BY E. JACKSON, 649.
post-operative hemostasis in, 237.
structures of, 660.
tumors of, extirpation of, 822, 834.
vascular and nervous supply of, 664.
Orbital axes, 818.
cavities, structure of, 813.
cysts, extirpation of, 837.
disease due to nasal disease, 1618.
margin, resection of, 847.
ORBITAL MUSCLES, OPERATIONS ON; BY E. JACKSON, 649.
septum, 1471.
ORBITAL WALLS AND CONTENTS, SOME OPERATIONS ON; BY C. A. WOOD, 813.
injuries to, 809.
operations on, 845, 848.
Orbito-sinus exenteration, 834.
Osteomata, orbital, extirpation of, 850.
Outetomie for glaucoma, 1082.

P

Pagenstecher's entropion operation, 1504.
intracapsular cataract extraction, 1251, 1257.
knife-needle, 477.
multiple retino-choroidal puncture for detached retina, 1373.
pterygium operation, 872.
ptosis operation, 1525, 1527.
spoon, 484.
Pallucci's cataract incision, 1150.
knife, 1148.
Palpebral muscles, 1392.
Pamard's cataract knife, 1145, 1148.
Panas' after-cataract operation, 1337.
cataract incision, 1152.
entropion operation, 1484, 1513.
irido-sclerotomy for glaucoma, 1082.
keratectomy, 581.
ptosis operation, 1534.
symblepharon operation, 1460.
syringe, 1192.
tarsorrhaphy, 1400.
tendon-stretching, 742.
Pannus, operations for, 917.
Panophthalmitis and enucleation, 542.
postoperative 272, 1297.
Papilloma, epibulbar, 645.
Paquelin's cautery, 506, 933.
points, 935.
PARACENTESIS AND OTHER OPERATIONS ON THE CORNEA; BY C. A. OLIVER, 942.
of cornea, 926, 944, 950.
in glaucoma, 1078.
in retinal embolism, 1386.
of sclera, 1358.
Paraffin in Mules' operation, 602.
injections, 440.
syringe, 505, 605.
Paralysis, oculomotor, transplantations for, 741.
of external rectus, operation for, 740.
Parasites, orbital and intraocular, operations for, 857.
Parinaud's division of check ligaments, 742.
ptosis operation, 1561.
strabismus operation, 744.
T-shaped sclerotomy, 1128.
Parker's maxillary sinus operation, 1651.
Pascheff's iridotome, 478.
Passavant's iridolysis, 1060.
Patient, duties of at operation, 194.
preoperative treatment of, 207.
preparation of for enucleation, 503.
general anesthesia, 1388.
operation, 211.
Paul of Ægina, 20, 21.
Pedrazzoli's lid speculum, 504.
Pellier's cataract incision, 1150.
knives, 1147.
Penetrometer, 317.
Peridectomy, peritomy, 918, 919, 920, 947, 949.
Peritomy, 920, 947.
Petit, François Pourfour, 32.
Petit's incision of tear-sac, 1591.
Pflüger-Eissen syringe, 1371, 1372.
Pflüger's glaucoma operation, 1082.
Pflugk's injection apparatus, 442.
method of sterilzing lid edges, 214.
Phantom face, 185.
Phenol, 400.
Phipps' cataract knife, 1147.
Phlebotomy, 456.
Pick's method of forming the stump after Mules' operation, 608.
Pilz's trachoma operation, 884.
Pince-ciseaux, 1088.
Pinguecula, 880.
Pipettes, ophthalmic, 410.
Pituitary gland, operations on, 1710.
Plato, 20.
Poisoning, ocular signs of, 128.
Polypus, epibulbar, 643.
Pond's styles, 1596.
Pope's cataract knife, 1148.
POSEY, WM. CAMPBELL: OPERATIVE TREATMENT OF GLAUCOMA, 1064.
Position of patient for discission, 1295.
Post's discission knife, 478.
knife-needle, 1328, 1332.
strabismus operation, 668.

Post-operative dietetics, 282.
dressings in cataract extraction, 1181.
treatment, 204, 265, 268.
POST-OPERATIVE TREATMENT; BY E. C. ELLETT, 235.
Postretinal fluid, electrolysis of, in retinal separation, 1372.
Pott's discission of cataract, 1291.
Powder stains, method of removing, 806.
Powers' instrumental rotation of lens, 1214.
Poyet's cataract incision, 1150.
knife, 1145.
Poyset's cataract knife, 1148.
Price's suture plate, 240.
Primrose's pannus operation, 919.
Prince's advancement forceps, 492, 677.
operation, 711, 712.
canthoplasty, 1397.
divulsor, 488.
expression forceps, 496.
fixation forceps, 493.
frontal sinus operation, 1641.
lid retractor, 488.
pterygium operation, 868.
turbinal forceps, 1643.
Pritchard's enucleation operation, 554.
Probe and spatula, combined, 1088.
Probes, canalicular, 481.
frontal sinus, 1630, 1633.
lachrymal, 481, 1585, 1589.
sphenoid, 1677.
Proeller's operation for total staphyloma, 983.
Proptosis, aneurysmal; see Exophthalmos, pulsating.
Protheses, 457, 597, 639, 830.
Pseudo-pterygium, 864, 880.
Pseudo-ptosis, 1520.
Pterygium, ancient Greek treatment of, 20.
knives, 20, 21, 474, 867, 868.
PTERYGIUM, OPERATIVE TREATMENT OF; BY W. T. SHOEMAKER, 861.
Ptosis, 1519.
PTOSIS, ETC., OPERATIONS FOR THE RELIEF OF; BY W. H. WILDER, 1464.
operations for, 1522.
Punches, antrum, 1655, 1656.
capsule, 1347.
for after-cataract, 1347.
sphenoid, 1680.
scissors-handled, 491.
Punch-forceps, nasal, 1625, 1628.
for sclerectomy, 1116.
Puncture, brain, 1725.
exploratory, orbital, 819.
in cataract extraction, 1166.
Puncture, lumbar, 1734.
multiple retino-choroidal for detached retina, 1373.
scleral or sclero-choroidal, 1358.
spinal, 1730.
Pupil, artificial, method of making, 1025.

Q

Quaglino's anterior sclerotomy for glaucoma, 1081.
Quarré François, 26.
Querenghi's sclero-choriotomy, 1122.
Questions, hypothetical, 68.
Quinin and urea bimuriate, 379, 406.
Quioc's capsulotomy, 1205.

R

Radiotherapy in trachoma, 905, 907.
Ramsay's method of localization, 344.
enucleation operation, 604.
paraffin syringe, 605.
Ramsey's styles, 1597.
Randolph and West's obliteration of lachrymal sac, 1604.
Rasps, frontal sinus, 1634.
REBER, WENDELL: ANESTHESIA IN OPHTHALMIC OPERATIONS, 377.
Reclinateur for cataract extraction, 1256, 1257.
RECLINATION AND MATURATION OF CATARACT; BY P. A. CALLAN, 1289.
Reclination of lens, 1312.
Rectus externus, tenotomy of, 687.
inferior, tenotomy of, 691.
internus, tenotomy of, 682.
more than one, tenotomy of, 692.
muscles, operations on, 737.
to weaken, 697.
operation for paralysis of, 740.
superior, tenotomy of, 690.
transplantation of, 738.
use of to correct paresis of the superior oblique, 737.
tenqon, change of direction of line of insertion of, 739.
Reese's muscle-shortening operation, 732, 734.
Reflector, adjustable, 518.
Regional anesthesia, 388.
Reich's cautery for trachoma, 901.
Reik's formalin sterilizer, 534.
Reimarus, Johann, 33, 34.
Reisinger, Franz, 35.
Reisinger's iris hook forceps, 492.
Repositors, 483, 485, 510, 1189, 1270, 1271.
Retina, detached, 1351.
attachment of to scleral wound, 1362.
bisection of retina and vitreous for, 1375, 1377.
discission of, 1361.
suturing of, 1366.
after cataract extraction, 1243.
embolism of central artery of, 1384.
incisions and punctures of, 1350.
injuries of, 804.
RETINA, OPERATIONS ON; BY C. A. WOOD, 1348.
Retina, surgical anatomy of, 1348.

Retinal veins, thrombosis of, 1076.
Retino-choroidal puncture, multiple for detached retina, 1373.
Retinoscope, electric, 308.
Retractors, 201, 487, 488
lachrymal, 506, 509.
lid, for couching, 1313.
Retrociliary cataract extraction, 1225.
Reverdin's grafts, 1405, 1406.
Rhigoline spray, 400.
Rhinorrhaphy, 1563.
Richards' frontal sinus operation, 1641.
Richet's blepharoplasty, 1444.
canthoplasty, 1397.
Richter's cataract incision, 1150.
cataract knife, 480, 1148.
intracapsular cataract extraction, 1248.
staphyloma operation, 975.
Ring's mask, 252, 418, 764.
Risley's knife-needle, 1327, 1329.
Ritterich's cystotome, 1190.
Robertson's ectropion operation, 1414, 1436.
maxillary sinus operation, 1660.
Rochon-Duvigneaud's spring scissors, 489.
transilluminator, 295, 296.
Roe's antrum punch, 1656.
Roentgen ray, 315.
equipment, 316.
in trachoma, 905.
Rogman's epicanthus operation, 1566.
Rohmer's glaucoma operation, 1133.
Roller bandages, 420.
forceps, 494.
Rollet and Moreau's treatment of hypopyon, 960.
Rollet's blepharoplasty, 1443.
method of forming the stump after Mules' operation, 607.
ptosis operation, 1540.
Romans, ophthalmology among, 21.
Rondeau's optico-ciliary neurotomy, 618.
Roosa's intracapsular cataract extraction, 1256.
Roosbrock's keratoconus operation, 1011.
Rosas' cystotome, 1190.
Rubefacients, 450.
Rust's roller forceps, 890.

S

Sac, lachrymal; see Lachrymal sac.
Sachs' operation for iris scar, 1063.
transilluminator, 297.
Saemisch's keratotomy, 779, 957.
Saint Yves' pterygium operation, 865.
Samelsohn's symblepharon operation, 1461.
Sanitary legislation, 132.
Santa Anna's cataract knife, 1147.
Santerelli's cataract incision, 1150.
knife, 1146, 1147.
Sarcoma, epibulbar, 646,
Sattler's curettage for trachoma, 896.
keratoconus operation, 971.
trachoma operation, 884.
Saunders, John, 37.
Sauvineau's advancement suture, 716.
Savage's cataract detacher, 501, 1257.
muscle-shortening, 723.
Saws, antrum, 1653.
Scalpel, iris, for after-cataract, 1339.
Scalpels, 473.
Scalp hemorrhage, method of controlling, 1693.
Scar; see Cicatrix.
Scarpa, 37.
Scarpa's discission of cataract, 1292.
pterygium operation, 865.
Schapringer's spud, 488.
Scheffel's obliteration of lachrymal sac, 1604.
Scheiner, 26.
Schenkel's magnet, 352.
Scherk's iridectomy knife, 1105.
Schloffer's hypophysis operation, 1714.
Schlosser's magnet, 352.
Schmidt, Johann, 32, 34.
Schmidt's method of forming the stump after enucleation, 568.
Schmidt-Rimpler's canaliculus knife, 1582.
syndectomy, 950.
test for simulated blindness, 93.
Schoch's operation for nasal duct obstruction, 1593.
Schöler's conjunctivoplasty, 992.
instruments for intraocular injection, 1370.
iodin injections in retinal detachment, 1369.
optico-ciliary neurotomy, 616, 618.
Schulek's corneal incision, 1195.
sphincterolysis anterior, 1062.
Schust's cataract incision, 1150.
Schweigger's canaliculus knife, 1582.
corneal section downward, 1193.
cystotome, 476.
muscle-shortening operation, 733.
optico-ciliary neurectomy, 619.
de Schweinitz' advancement suture, 716.
method of enucleation, 569.
Schwenk's modification of the Guthrie-Saemisch section, 958.
Scissors, 489, 496.
for after-cataract, 1343.
intracapsular extraction, 1273.
iris, 1030, 1088, 1188, 1343, 1344, 1345.
nasal, 1625.
optic nerve, 624, 625.
strabismus, 676, 677, 678.
Sclera, alterations in due to nasal disease, 1615.
cauterization of for retinal detachment, 1374.
foreign bodies in, 787.

Sclera, incisions through for retinal detachment, 1365.
injuries to, 281, 785.
ruptures of, 787.
surgical anatomy of, 924.
tumors of, 643.
wounds of, 281, 785.
Scleral ectasiæ, transillumination of, 303.
puncture, 1358.
sutures, 785, 787.
wall, resection of for detached retina, 1381.
Sclerectomy for glaucoma, 1117.
punch-forceps for, 1116.
Scleriritomy, 1083.
Sclero-choriotomy for glaucoma, 1122, 1129.
Sclero-choroidal puncture, 1358.
Sclero-corneal incision in cataract extraction, 1167, 1178, 1229.
Sclero-cyclo-iridic puncture for glaucoma, 1085.
Sclerocyclotomy for glaucoma, 1122.
Sclero-dilatatorectomy in glaucoma, 1108.
Sclero-iridectomy in glaucoma, 1091, 1108.
Scleronyxis, reclination by means of, 1315.
Sclerostome, 1120, 1121.
Sclerotomia antero-posterior for glaucoma, 1085.
Sclerotomy, anterior, in glaucoma, 1079.
combined, for glaucoma, 1083.
in retinal embolism, 1386.
lancet for couching, 1313.
posterior, 1358.
in glaucoma, 1126.
small equatorial in glaucoma, 1128.
T-shaped, in glaucoma, 1128.
Scoop, evisceration, 588.
Scopolamin-morphin in ophthalmic operations, 386.
Scotomata, tests for simulation of, 91.
Scott's ectropion operation, 1438.
Scrini's massage for trachoma, 897.
Sedatives, 268.
Septum orbitale, 1471.
Serum diagnosis and therapy, 456.
Sgrosso's operation for keratoconus, 970.
Sharpness of instruments, tests for, 232, 512, 1185.
Sharp's cataract extraction, 1143.
cataract knife, 1145, 1148.
intracapsular cataract, extraction of, 1248.

SHASTID, THOMAS HALL: FORENSIC RELATIONS OF OPHTHALMOLOGY, 43.

Shields after cataract extraction, 1182.

SHOEMAKER, WILLIAM T.: OPERATIVE TREATMENT OF PTERYGIUM, 861.

Sichel, 38.
Sichel's iridotome, 1327.
knife-needle, 477.
Siderophone, 313.
Sideroscope, 309, 311, 314.
Sight after cataract extraction, 1244, 1245.
reattachment of retina, 1355.
Sigwart's cataract incision, 1150.
Silbermark's hypophysis operation, 1711.
Silcock's keratoconus operation, 965.
Sillonneur, 904.
Simi's equatorial sclerotomy, 1129.
Simulation of injuries, 90.
Sinus disease causing ocular disease, 1615.
X-ray diagnosis of, 321.
knives, 1626.
suction apparatus, 1622.
Sinus; see also Cavernous, Frontal, Maxillary, Sphenoidal sinuses, etc.
Skeel's spoons, 484.
Skin grafting, methods of, 1402.
Sleep, ocular signs of, 128.
Sluder's knife, 1626.
maxillary sinus operation, 1653.
Smith's after-cataract operation, 1337.
balance for testing edged instruments, 1185.
intracapsular cataract extraction, 1261, 1274, 1275.
extraction instruments, 1263, 1265.
lamp for ward use, 522.
lid hook, 792.
method of enucleation, 568.
partial tenotomy, 699.
preliminary capsulotomy, 1207.
spatula, modified, 1272.
toilet of wound, 1284.
Snare, nasal, 1627.
Snell's electric spud and knife-needle, 309, 782.
electro-magnet, 349.
method of forming the stump after enucleation, 567.
passive motion, 742.
Snellen's artificial eyes, 459, 639.
collyrium, bottle, 229.
ectropion operation, 1413.
entropion operation, 1512.
suture, 1477, 1479.
lid clamp, 238.
protheses, 459, 639.
ptosis operation, 1547.
symblepharon operation, 1460.
test for simulated blindness, 97.
wire loop, 485.
Snydacker-Morax autoplasty, 1437, 1438, 1439.
Snyder's operation for eversion of lids, 1583.
Solomon's strabismus operation, 673.
Somnoform, 383.
Sounds, 482.
subdural, 1699.

Sourdille's ptosis operation, 1543.
Spatula, 1031.
and blunt-pointed probe, combined, 1088.
for cataract extraction, 1265, 1270, 1272.
trachoma, 902, 903.
iris, 1189.
Specula, 199, 1185, 1186.
for cataract extraction, 1265, 1269.
insertion of, 1165.
Lawford's, 215.
lid, 503.
optic nerve, 507.
Sperino's intracapsular cataract extraction, 1250.
Sphenoid, curette, 1670.
disease, diagnosis of, 1674.
ocular symptoms of, 1677.
operations for, 1678.
instruments, 1677.
punch, 1680.
sinus, surgical anatomy of, 1673.
Sphincterolysis, 1058.
anterior, 1062.
Spinal puncture, 1730, 1734.
Sponges, 229.
gauze, 257.
Spoons, 484, 485.
enucleation, 559.
for cataract extraction, 1263.
Spratt's enucleation operation, 603.
Sprays, 416.
Spud and knife-needle, electric, 308.
needle, combined, for removal of foreign bodies from cornea, 944.
electric lighted, 782.
Spuds, 486, 487.
Squint; see Strabismus.
Stains for corneal ulcer, 939.
Stanculeanu's speculum for excision of the optic nerve, 507.
STANDISH, MYLES: OPERATIONS FOR AFTER-CATARACT, 1320.
Stands, 520.
Staphylectomy, 978.
Staphyloma, corneal, 772.
operations, 581, 589, 590, 972, 978, 1061.
pellucidum conicum; see Cornea, conical.
Staphylotomy, 1061.
Steffans' cataract incision, 1153.
Stein's maxillary sinus operation, 1653.
Stellwag's incision of corneal staphyloma, 977.
Stephenson's elongation of tendons, 701.
lachrymal retractor, 506.
tendon-lengthening incision, 704.
thermo-cautery, 510.
Stereoscope localization, 326.
Sterilization of instruments, 230, 526, 527.
of operator's hands, 219.
Sterilizer's and sterilizing, 532.
Sterns-Semmereole sclerotomia anteroposterior for glaucoma, 1085.
Stevens' extendo-contraction of rectus, 739.
lid speculum, 504.
needle-holder, 499.
strabismus hook, 486.
scissors, 497, 678.
tendon resection, 725.
Stevenson's advancement forceps, 494.
suture, 718, 719.
(Bernay) nasal tampon, 1628.
capsule punch, 491, 1347.
capsulotomy, 1209.
lachrymal sac retractor, 509.
lid speculum, 503.
needle forceps, 677.
needle-holder, 499.
trachoma forceps, 500.
Stillicidium, operation for, 1580.
Stop-needle for after-cataract, 1337.
Story's entropion operation, 1501.
Stovaine, 404.
infiltration anesthesia, 397.
Strabismus, comitant, choice of operation in, 750.
divergent, operation for, 744.
forceps, 492, 677.
history of operation for, 665.
hooks, 486, 487, 670, 671, 677, 678, 727.
instruments, 676.
operations, classification of, 673.
indications for, 745.
position in, 675.
paralytic, choice of operation for, 751.
scissors, 497, 498, 677, 678.
Streatfeild's entropion operation, 1511.
iridolysis, 1059.
extirpation of conjunctival sac, 833.
Stretchers for ophthalmic patients, 527.
Stricturotomy, 1588.
Stromeyer, George, 37.
Stromeyer's strabismus operation, 667.
Stroschein's bottle, 413, 414.
apparatus for sterilizing ophthalmic solutions, 533.
triple strabismus hook, 728.
Strouse's grattage, 893.
Strumectomy, 1744.
Stump, formation of after enucleation, 566.
Mules' operation, 592, 597, 602.
Sturmann's maxillary sinus operation, 1659.
Stye, 1569.
Styles, 484.
in nasal duct obstruction, 1593.
Subconjunctival anesthesia in enucleation, 548.
extraction of cataract, 1221, 1222.
injections, 435.
for detached retina, 1366.
tenotomy, 686, 688.

Subcutin, 424.
Subdural sound, 1699.
Subretinal fluid, aspiration of, 1361.
sac, iodine injections into, 1372.
permanent drainage of, 1362.
Suction apparatus, sinus, 1622.
removal of cataract, 1297.
Suffa's tendon-tucking stitch, 724, 725.
Suker's enucleation forceps, 494.
method of forming the stump after enucleation, 567, 606.
operation for delayed implantation, 616.
Sulzer's electro-magnet, 349.
Superciliary muscles, 1390.
Superior oblique, tenotomy of, 703.
rectus, tenotomy of, 690.
SURGEON, DEVELOPMENT OF OPERATIVE SKILL IN; BY A. E. BULSON, 179.
preparation of for enucleation, 553.
Surgeon's masks, 217.
SURGERY, OPHTHALMIC, INSTRUMENTS USED IN; BY P. GUILFORD, 469.
SURGERY, OPHTHALMIC, PREOPERATIVE TECHNIQUE OF; BY W. G. M. BYERS, 205.
SURGICAL TREATMENT OF INJURIES TO THE VISUAL APPARATUS; BY H. V. WUERDEMANN, 755.
Suture plate, Price's, 240.
Sutures, 229.
and their removal, 239.
conjunctival, after cataract extraction, 1219.
continuous, 241.
corneal, 777.
after cataract extraction, 1220.
entropion, 1477.
interrupted, 240.
scleral, 785, 787.
tendon-tucking, 724.
tension, 241.
Suturing of detached retina, 1366.
Swabbing, 432.
Swabs, 229.
Swanzy's advancement suture, 716.
Sweat bath, 454.
Sweet's hand magnet, 352.
method of localization, 328.
operation for implantation of metal ball in Tenon's capsule, 612.
Sympathectomy, 1763.
Symblepharon, operations for, 1451.
shells to prevent, 459.
Syndectomy, 918, 919, 920, 947, 949.
Synechiæ, iridic, operations for, 1058.
scissors, 499.
Syphiloma, cerebral, operation for, 1706.
Syringes, 505, 509, 1664.
anterior chamber, 1192.
ear and ulcer, 263.
for use in retinal separation, 1371, 1372.
Syringes, intraocular, 511, 1377.
lachrymal, 417, 1591, 1592.
paraffin, 605.
Syringe-pump for aspiration of soft cataract, 1299.
Systemic examination, preoperative, 207.
treatment, preoperative, 207.
Szokalski's pterygium operation, 865.
Szymanowski's ectropion operation, 1420, 1421, 1422.

T

Tables, operating, 189, 537, 1694.
ward, 520.
Tagliacotian method of autoplasty, 1447.
Tampon, nasal, 1628.
Tansley's lachrymal probe, 483.
style, 484.
ptosis operation, 1539.
Tarsi, 1470.
Tarsoplasty, 1505.
Tarsorrhaphy, 1398.
TARSORRHAPHY, CANTHOPLASTY, ETC.; BY C. H. BEARD, 1388.
Tarsus, correction of distortion of, 1476, 1502.
excision of, 910.
for trachoma, 916.
Tattooing needles, 478, 479, 1002.
of cornea, 468, 574, 996.
Taylor's, Bell, cataract incision.
Taylor, John, 36.
method of preventing iris prolapse, 991.
tying off the canaliculus, 760.
strabismus operation, 665.
Teale-Knapp symblepharon operation, 1456, 1457.
Teale's suction apparatus for cataract, 1298.
symblepharon operation, 1455.
Tendino-capsular advancement, 722.
Tendon clamp, 730.
hooks, 487.
Tendons, elongations of by division and suture, 701.
exsection of, 743.
Tendon-folding, by suture, 722.
with triple hook, 727.
Tendon-stretching, 742.
Tendon-tuckers, 509, 510.
Tenon, 32.
Tenon's capsule, tenotomy extended to, 696.
cataract knives, 1145, 1147.
Tenotome, 501.
Tenotomy by the open method, 679.
complications of, 276.
of the external rectus, 687.
the inferior rectus, 691.
internus, 682.
superior rectus, 690.
partial, 697.

Tenotomy scissors, 500.
subconjunctival, 670, 686, 688.
without the hook, 685.
Terson's capsulotomy, 1211, 1212.
ectropion operation, 1429.
intracapsular cataract extraction, 1253.
sclero-iridectomy in glaucoma, 1108.
Testimony, expert, 60.
ophthalmic surgical aspects of, 78.
Teter's anesthesia apparatus, 384, 385.
Theobald's hypopyon treatment, 960.
iris scissors, 500.
lachrymal probes, 1589.
ptosis operation, 1553.
probes, 481.
Thermal treatment, 448.
Thermo-cautery, 510.
in corneal ulcer, 932.
points, 935.
Thiersch's grafts, 1405, 1407.
in symblepharon, 1461.
Thomas' lachrymal knife, 475.
Thompson's operation for removal of lachrymal sac, 1602.
staphyloma operation, 581.

THOMSON, EDGAR S.: ELECTRIC APPLIANCES IN OPHTHALMIC SURGERY, 284.

Thomson's advancement sutures, 717.
tattooing instrument, 479.
Thread operations to increase effect of tenotomy, 672, 969.
Thrombosis of retinal veins, 1076.
Thyroid arteries, ligation of, 1755.
enucleation, intraglandular, 1751.
incision and drainage of, 1753.
ligation of superior poles of, 1758.
Thyroidectomy, 1743.
dangers and complications of, 1748.
unilateral, 1758.
Tillaux's enucleation method, 572.
Todd's cautery instrument, 778, 953, 955.
enucleation method, 569.
foreign body instrument, 784.
irrigator, 265, 415, 508, 758.
partial tenotomy, 701.
spud, 487.
tendon-folding operation, 729, 730.
tendon-tucker, 729, 509.
Toilet of wound, Smith's 1284.
Tooke's capsule forceps, 479, 494, 1213, 1214.
Trachoma among the ancient Romans, 21.
cauterization for, 289.
electrolysis for, 294.
expression instruments, 887, 890.
files, 488.
forceps, 500.
hook, 901.
in early 19th century, 36.
knife, 904.

TRACHOMA, OPERATIONS AND OTHER SURGICAL TREATMENT FOR THE RELIEF AND CURE OF; BY J. GREEN, JR., 881.

historical review of, 883.
pathology of, 882.
spatula, 902, 903.
stages of, 885.
Trachomatome, 894.
Transfixio iridis for glaucoma, 1121.
Transillumination, 295, 299.
Transilluminator, 782.
Transplantation of animals' eyes, 630.
Trauma; see Injuries and Wounds.
Travers' cataract incision, 1150.
Trays, 520.
Treatment, post-operative, 204, 265, 268.
preoperative, 207.
tray, 261.
Trephine, antrum, 1651.
corneal, 1004, 1022.
scleral, in glaucoma, 1118.
Trichiasis, 1473.
electrolysis for, 292.

TRICHIASIS, ETC., OPERATIONS FOR RELIEF OF; BY W. H. WILDER, 1464.

Trocars, antrum, 1649.
Tropacocain, 404.
Trousseau's capsular ligature, 726.
Truc's ectropion operation, 1430.
Tuberculoma, cerebral, operation for, 1706.
Tumors, bony orbital, removal of, 849.
cerebellar, 1709.
cerebral, operations for, 1701.
dermoid epibulbar, 645.

TUMORS, EPIBULBAR, OPERATIVE TREATMENT OF; BY G. S. DERBY, 643.

hypophyseal, operation for, 1710.
intraocular, 1075.
of eyelids, operations on, 1572.

TUMORS OF THE EYELIDS, REMOVAL OF; BY W. H. WILDER, 1464.

lachrymal gland, 1608.
iris, 1043.
optic nerve extirpation of, 824.
orbital, extirpation of, 822, 834.
X-ray diagnosis of, 321.
Turbinal forceps, 1643.
Turbinotome, 1627.
Tweedy's ectropion operation, 1434, 1435.
Tyrrell's blunt iris hook, 486, 1088.
keratoconus operation, 963, 1008.
staphyloma operation, 979.
Tyson's corneal tattooing operation, 1002.

U

ULCER AND FISTULA, CORNEAL, SURGICAL TREATMENT OF; BY H. B. CHANDLER, 923.

corneal, cauterization of, 778.
iridectomy in, 1042.

Ulcer of cornea, paracentesis in, 944.
stains for, 939.
surgical treatment of, 926.
hypopyon, 939.
operation for, 779, 959.
rodent, of cornea, 937.
Undines, 214, 264, 411, 413, 759.
Unguipressio, 887.
United States, legal principles in, 44.
malpractice in, 146.
ophthalmo-sanitary laws in, 132.
Uveal tract, injuries of, 790.
Uveitis due to sinus disease, 1616.

V

Vacher's igneous peritomy, 948.
punch-forceps, modified, 1116.
Vail's maxillary sinus operation, 1654.
Valude's advancement operation, 714, 715.
Van Lint's electrolytic peritomy, 948.
Van Millingen's entropion operation, 1499.
trichiasis operation, 1498.
Van Struycken nasal punch forceps, 1625.
Vaso-constrictors, 453.
Veasey's portable sterilizer, 533.
Veins, retinal, thrombosis of, 1076.
Venesection, 456.
see also Blood-letting.
Ventilation in hospitals, 513.
Verhoeff's advancement stitch, 719, 720.
cataract operation, 1200.
partial plastic tenotomy, 700.
sclerostome, 1120, 1121.
Vesicants, 452.
Vetch, John, 37.
Vienna mask, 184.
method of enucleation, 575, 576, 577.
Vieusse's test for simulated blindness, 96.
de Vincentiis' incision of the iris angle for glaucoma, 1084.
Vision after cataract extraction, 1244, 1245.
reattachment of retina, 1355.
power of, 120.
VISUAL APPARATUS. SURGICAL TREATMENT OF INJURIES TO; BY H. V. WUERDEMANN, 755.
fields, disturbance of, 1613.
Vitreous and retina, bisection of for retinal detachment, 1375, 1377.
animal, injection of, for detached retina, 1377.
loss of, in cataract extraction, 1232.
membranes, discission of in retinal detachment, 1364.
Volkmann's magnet, 353.
Vollert's optic nerve scissors, 625, 628, 629.
von Ammon, von Arlt, von Eiselsberg, etc.; see under Ammon, Arlt, Eiselsberg, etc.

W

Wadsworth's ball cautery, 933, 934.
Waldau's cataract incision, 1150.
Waldeau's spoon, 484.
Walker's glaucoma operation, 1122.
iridolysis, 1060, 1061.
kerotomy, 955.
Walmsley's canulæ, 485.
Walther's ectropion operation, 1418.
tarsorrhaphy, 1398, 1399.
Ward and room lighting, 519.
furnishings, 518.
test for color blindness, 523.
Wards for major ophthalmic operations, 521.
WARDS, OPHTHALMIC; BY T. A. WOODRUFF, 513, 527.
in general hospitals, 528.
size of, 517.
Wardrop, James, 37.
Wardrop's cystotome, 1190.
Ware's posterior sclerotomy, 1360.
staphyloma operation, 975.
styles, 1593, 1595.
Warlomont's lid clamp, 502
entropion operation, 1504.
Wash bottles, 758.
see also Irrigators.
Washes for the eye, 409.
Water bags, 447.
sterilizer, 536.
Waters for the eye, 409.
Wathen's styles, 1593.
Watson's trichiasis operations, 1493, 1495.
Weber's canaliculus knives, 1582.
cataract knife, 1152, 1154.
capsulotomy, 1204.
cystotome, 1191.
double hook, 486.
iridolysis, 1059.
lachrymal knives, 475.
wire loop, 485.
de Wecker, 28.
de Wecker's anterior sclerotomy for glaucoma, 1079.
capsular advancement, 722, 723.
capsulotomy, 1204.
cataract incision, 1152, 1154.
chalazion spoon, 484.
combined sclerotomy for glaucoma, 1083.
curette, 928.
double hook, 486.
clamp, 678.
ectropion operation, 1426.
galvano-puncture in retinal detachment, 1363.
iridoectomy, 1053, 1054.

de Wecker's iridotomy, 1046, 1047.
scissors, 1344, 1345.
keratoconus operation, 967.
muscle-shortening operation, 723.
permanent drainage of subretinal sac, 1362.
ptosis operation, 1531.
purse-string enucleation, 566, 569.
scissors, 490, 1088, 1343, 1345.
staphyloma operation, 981, 982, 983.
tattooing operation, 574.
temporary conjunctival covering, 773.
Wedge-isolation operation in glaucoma, 1114.
Weeks' discission knife, 478.
knife-needle, 1328, 1329, 1333.
operation for cicatricial orbit, 1463.
Weller's cataract incision, 1150.
de Weltz enucleation spoon, 559.
de Wenzel's cataract incision, 1150.
knife, 1147.
cystotome, 1190.
Wescott's corneal curette, 928.
iris forceps-scissors, 490.
tenotomy scissors, 500.
West's hypophysis operation, 1717.
lachrymal duct operation, 1662.
Wheeler's spoon, 484.
Whitney's roller forceps, 890.
Wicherkiewicz' epicanthus operation, 1566.
Wilde's staphyloma operation, 980.
strabismus operation, 672.
WILDER, WM. H.: OPERATIONS FOR THE RELIEF OF TRICHIASIS, ENTROPION, PTOSIS AND EPICANTHUS; REMOVAL OF TUMORS OF THE EYELID, 1464.
Wilder's chalazion clamp, 502.
dilator, 792.
entropion knife, 1518.
operation, 1517.
lachrymal syringe, 505, 509.
ptosis operation, 1555.
Willburg's reclination operation, 1315.
Williams' advancement operation, 712, 713.
corneal suture, 1221, 1222.
entropion operation, 1509.
method of abscission, 579.
preventing iris prolapse, 991.
probes, 481, 482.
Witnesses, expert, 60.
Wolfe's grafts, 1405, 1408, 1410.
hypopyon operation, 959.
keratoconus operation, 971.
scleral incision for retinal detachment, 1365.
Wolff's ptosis operation, 1547.
WOOD, CASEY A.: EXTRACTION OF THE SENILE TYPE OF CATARACT, 1135.
WOOD, CASEY A.: OPERATIONS ON THE RETINA, 1348.
WOOD, CASEY A.: REMEDIES, APPLIANCES AND PROCEDURES IN MINOR OPHTHALMIC SURGERY, 408.
WOOD, CASEY A.: SOME OPERATIONS ON THE ORBITAL WALLS AND CAVITY, 813.
Wood's cataract operation, 1159.
hypopyon procedure, 960.
WOODRUFF, THOMAS A.: OPHTHALMIC HOSPITAL WARDS AND ROOMS, THEIR FURNISHING AND EQUIPMENT, 513.
Woodruff's tendon-tucking stitch, 724.
Woolhouse, Thomas, 31, 36.
Woolhouse's grattage, 893.
staphyloma operation, 973.
Wootton's advancement suture, 716.
Wordsworth-Todd's cautery, 274, 506.
Worth's advancement sutures, 717.
ptosis operation, 1529.
Wounds cataract infection of, 1236.
cleaning of, 239.
infected, 762.
cauterization for, 289.
ocular, surgical treatment of, 761.
scleral, 785.
Wright's intracapsular cataract extraction, 1254, 1255.
WUERDEMANN, HARRY VANDERBILT: SURGICAL TREATMENT OF INJURIES TO THE VISUAL APPARATUS, 755.
Würdemann's base-ball cataract shield, 1183.
lamp, 782.
mattress suture, 789.
method of forming the stump after enucleation, 568.
pouch conjunctival suture, 774.
transillumination, 298, 299, 782.

X

Xanthelasma, electrolysis for, 293.
X-rays, 315.
X-ray equipment, 316.
in trachoma, 905.

Y

Yohimbin, 406.
Young, Thomas, 35.
Young's cataract knife, 1144, 1146.
pterygium knife, 474, 867, 868.

Z

Ziegler's cystotome, 1191.
ectropion operation, 1414.
iridotomy, 1049.
for after-cataract, 1341.
irrigator, 508.

Ziegler's knife-needle, 1327.
lid clamp, 501.
probe, 482.
De Zeng's electric ophthalmoscope, 304, 305, 306.
retinoscope, 308.
Zervos' transplantation operations, 631.
Zimmerman's extirpation of lachrymal sac, 1604.
operation for retinal detachment, 1364.
Zinn, Joh., 32.
Zirm's treatment of hypopyon, 961.
Zonulatome for intracapsular cataract extraction, 1257.

STORAGE
UNIVERSITY OF TORONTO
LIBRARY
Do not
remove
the card
from this
Pocket.
Acme Library Card Pocket
Under Pat. "Ref. Index File."
Made by LIBRARY BUREAU